



Society for Risk Analysis

Risk Analysis: Risk Analysis in Action!



2010 Annual Meeting

December 5-8, 2010

Salt Palace Convention Center

Marriott Salt Lake City Downtown

Salt Lake City, Utah

Final Program

Marriott Salt Lake City Downtown

75 South West Temple
Salt Lake City, Utah 84101
801-531-0800

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www.SRA.org

**SRA Headquarters, 1313 Dolley Madison Boulevard, Suite 401, McLean, Virginia 22101
703.790.1745; FAX: 703.790.2672 SRA@BurkInc.com**

Society For Risk Analysis Annual Meeting

2010 Final Program

Table of Contents

| | |
|--|--------------------|
| Meeting Highlights | 1 |
| Schedule at a Glance | 2 |
| Registration Hours/Conference Events..... | 5 |
| Specialty Group Meetings..... | 5 |
| Specialty Group Mixers..... | 5 |
| Exhibitors/Exhibition Hours/Books on Display | 6 |
| Workshops | 9 |
| Plenary Sessions..... | 15 |
| Scientific Program Sessions | 16-21, 26-39 |
| Poster Session | 22-25 |
| Symposia Descriptions | 40-51 |
| Abstracts | 52 |
| Author Index..... | 197 |
| Marriott Floor Plan | Inside Back Cover |
| Convention Center Floor Plan | Outside Back Cover |

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 5, 6:00-7:30 PM), and continue to the closing (Wine and Cheese - Cash Bar) reception on Wednesday (December 8, 5:00-6:00 PM). The meeting includes three Plenary Sessions and lunch on all three days.

Location this Year!

This year's meeting is being held at the Marriott Salt Lake City Downtown and Salt Palace Convention Center in Salt Lake City, Utah. Check the location of each event, and use the maps on the inside and outside back covers.

Oral Presenter's Reminder

If you are an Oral Presenter at the meeting, don't forget to upload your presentation in the Speaker Ready Room (Room 250E) at least 24 hrs prior to your presentation.

If you have already uploaded your talk, come by the Speaker Ready Room to ensure it has been received and uploaded correctly.

| 250A | 250B | 250C | 250D | 250F |
|---|---|---|---|---|
| Monday 10:30-11:30 AM M2-A Symposium: Analysis and the Policy Process 1:30-3:00 PM M3-A Symp: 30 Years After the Benzene Decision: When will Risk Assess Benefit Workers? Part 1 3:30-5:00 PM M4-A Symp: 30 Years After the Benzene Decision: When will Risk Assess Benefit Workers? Part 2 | Monday 10:30 AM-Noon M2-B Symp: Decision Support Methods for Nano Risk Assess and Risk Management Part 1 1:30-3:00 PM M3-B Symp: Decision Support Methods for Nano Risk Assess and Risk Management Part 2 3:30-5:10 PM M4-B Ecological Risk Analysis In Action Part 1 | Monday 10:30 AM-Noon M2-C Energy Futures 1:30-3:00 PM M3-C Industry Safety and Release Responsibilities 3:30-5:10 PM M4-C Theoretical constructs in risk: trust and uncertainty | Monday 10:30 AM-Noon M2-D Symposium: Biologically-Based Dose Response Models-Cancer 1:30-3:00 PM M3-D Symposium: Salmonella in Low Moisture Foods: Understanding & Quantifying 3:30-5:10 PM M4-D Symposium: Advances in Estimation of Risk from Foodborne Illness | Monday 10:30 AM-Noon M2-E Symposium: Challenges & Opportunities at the Infra-Envi Nexus 1:30-3:10 PM M3-E Symposium: Reconstruction of Exposure & Dose 3:30-5:10 PM M4-E Symposium: Risk Analysis of System Independences |
| Tuesday 10:30 AM-Noon T2-A Symp: Health Assess, a Powerful Tool for Policy Matters, Who Needs it? How ... Used? 1:30-2:30 PM T3-A International Approaches to Risk 3:30-5:00 PM T4-A Symposium: Emerging Technologies: Dealing with Uncertainty in Risk Policy | Tuesday 10:30 AM-Noon T2-B Symposium: Food Applications of Engineered Nanomaterials Part 1 1:30-3:00 PM T3-B Symposium: Food Applications of Engineered Nanomaterials Part 2 3:30-5:10 PM T4-B Symp: Current Perspectives on Silver Nanomaterial Risk Assessment and Risk Management | Tuesday 10:30 AM-Noon T2-C Households and Farms: Drinking Water and Soil 1:30-3:00 PM T3-C Examining risk perception and communication in the context of aquatic environments 3:30-5:10 PM T4-C Dimensions of risk during extreme events | Tuesday 10:30 AM-Noon T2-D QMRA's of Salmonella in Pork 1:30-3:10 PM T3-D Special Methods Applied to Public Health 3:30-5:00 PM T4-D Symposium: Approaches Used to Understand and Assess Food | Tuesday 10:30 AM-Noon T2-E Response to Natural Disaster 1:30-3:00 PM T3-E Issues in Critical Infrastructure 3:30-5:10 PM T4-E Applications of Exposure Modeling |
| Wednesday 8:30-10:00 AM W1-A Symposium: TSSA and Modernization: Lessons Within Reach 10:30 AM-Noon W2-A Symposium: Contaminants in Water: Risk Assessment Challenge Ahead 1:30-3:00 PM W3-A Symposium: Methodologies for Global Catastrophic Risk Assessment 3:30-5:00 PM W4-A Smposium: Climate Change and Global Catastrophic Risk | Wednesday 8:30-10:00 AM W1-B Symposium: Mercury Selenium & Millions of Birds at the Great Salt Lake 10:30-11:30 AM W2-B Ecological Risk Analysis in Action II 1:30-3:00 PM W3-B Nano Risk Perception: Views from experts, the public and the media 3:30-5:10 PM W4-B Symp: Nothing New About Nano? Making Interdisciplinary Advances in Risk Perception Research | Wednesday 8:30-10:00 AM W1-C Symp: Risk Communication in the Wild: How Do We Know When We Have Succeeded? 10:30-11:30 AM W2-C Symp: Sustainability of Biofuels: Data Need to Support Environ & Public Health Perspective 1:30-3:00 PM W3-C The role of message framing and trust in communicating health risk 3:30-5:10 PM W4-C Risk and Engineering Systems | Wednesday 8:30-9:30 AM W1-D Challenges in Policy Analysis 10:30 AM-Noon W2-D Biologics and Devices & Public Health 1:30-3:10 PM W3-D Tungsten Compounds Research and Risk Assessment 3:30-5:10 PM W4-D Symposium: Microbial Risk Assessment Guidelines | Wednesday 8:30-9:30 AM W1-E Exposure Assessment: Bugs, Drugs, and Metals 10:30 AM-Noon W2-E Symposium: Infrastructure & Network Risk Analysis 1:30-2:30 PM W3-E Oil Spill Exposures 3:30-5:00 PM W4-E All Routes of Exposure |

| 251A/B | 251C/D | 251E | 251F | |
|---|--|--|---|---|
| <p>Monday 10:30 AM-Noon M2-F Evolving Technologies for Risk Communication</p> <p>1:30-3:00 PM M3-F Engaging the Public-Progress and Prespectives</p> <p>3:30-5:10 PM M4-F Risk governance and climate change requirements for risk governance</p> | <p>Monday 10:30 AM-Noon M2-G Poster Platform: QMRA Applied to Food Safety</p> <p>1:30-3:00 PM M3-G Professional Development Roundtable for Students and Young Professionals</p> <p>3:30-5:00 PM M4-G Symposium: Evaluating PBPK Models for Use in Risk Assessment</p> | <p>Monday 10:30 AM-Noon M2-H Symposium: Plausibility and Risk</p> <p>1:30-3:00 PM M3-H Decision Analysis Current State and Energy Ideas</p> <p>3:30-5:00 PM M4-H Symposium: Value of Information: What Has Been Done?</p> | <p>Monday 10:30 AM-Noon M2-I Symposium: Approaches to Modeling Adaptive Adversaries for Risk Analysis</p> <p>1:30-3:00 PM M3-I Symposium: Modeling Developmental Toxicity Data</p> <p>3:30-5:10 PM M4-I Adaptive Adversary Risk Analysis, Resource Allocation, and Intelligence Optimization</p> | <p>Specialty Group Meetings Noon-1:30 pm See page 5 for details</p> <p>Poster Reception 6:00-8:00 pm, Marriott Ballroom</p> |
| <p>Tuesday 10:30 AM-Noon T2-F Symposium: Communicating Evidence for Risk Characterization</p> <p>1:30-3:00 PM T3-F Assessment, Communication and Perception of Nanotechnology</p> <p>3:30-4:30 PM T4-F Risk perception, gender and behavior</p> | <p>Tuesday 10:30 AM-Noon T2-G Novel Approaches in Dose Response</p> <p>1:30-3:00 PM T3-G Symposium: Beyond Science and Decisions</p> <p>3:30-5:00 PM T4-G Future of Risk Assessment</p> | <p>Tuesday 10:30 AM-Noon T2-H Symposium: Emerging Contaminants: Implementing Solutions</p> <p>1:30-3:00 PM T3-H Crashes, Wrecks, & Emergencies PI</p> <p>3:30-5:00 PM T4-H Crashes, Wrecks, & Emergencies P.II</p> | <p>Tuesday 10:30 AM-Noon T2-I Symposium: Innovations in Benefit Cost Analysis</p> <p>1:30-3:00 PM T3-I Symp: All-Hazards Risk Analysis & Other Recent Advances in Homeland Security Risk Mgmt</p> <p>3:30-5:10 PM T4-I Symposium: The DHS Integrated Risk Management Framework</p> | <p>Career Fair 5:00-6:30 pm Room 151A-C, Salt Palace CC</p> <p>Specialty Group Mixers 6:00-7:30 pm See page 5 for details</p> |
| <p>Wednesday 8:30-10:00 AM W1-F Poster Platform: Microbial Path and Food Safety</p> <p>10:30 AM-Noon W2-F Perspectives on risk communication and perception in the health industry</p> <p>1:30-3:00 PM W3-F SARF (Social Amplification of Risk Framework): Applications and Adjustments</p> <p>3:30-5:00 PM W4-F Poster Platform: Risk Assessment of Inhaled Hazards</p> | <p>Wednesday 8:30-10:00 AM W1-G Symposium Roundtable: The New EPA Regulatory Approach to Drinking Water</p> <p>10:30 AM-Noon W2-G Probabilistic Risk Issues</p> <p>1:30-3:00 PM W3-G Analysis of Infectious Agents</p> <p>3:30-5:10 PM W4-G Risk in the World</p> | <p>Wednesday 8:30-10:00 AM W1-H Elicitation, Communication, Participation</p> <p>10:30 AM-Noon W2-H Mental Models, Psychology and Biology</p> <p>1:30-3:00 PM W3-H Public, Animal & Occupational Health</p> <p>3:30-5:00 PM W4-H Humans, Agents, and Models</p> | <p>Wednesday 8:30-10:00 AM W1-I Symposium: Understanding and Managing Public Response to Terrorism and Natural Disasters</p> <p>10:30 AM-Noon W2-I Symp: Intergrating Quantative and Qualitive Approaches to Achieve Resource and Security ...</p> <p>1:30-2:30 PM W3-I Food Safety and Sustainability</p> <p>3:30-5:10 PM W4-I Symposium: Mercury Exposure and Health Effect Reference Values</p> | <p>T-Shirt Giveaway/ Wine & Cheese Reception 5:00-6:00 pm Salt Palace Convention Center Registration Area</p> |

2010 Council

President: Richard Reiss

President-Elect: Rachel Davidson

Secretary: Henry Willis

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Treasurer-Elect: Jeff Lewis

Past President: Alison Cullen

Executive Secretary: Richard J. Burk, Jr.

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| | |
|------------------|------------------|
| | Daniela Leonte |
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| Sharon Friedman | Michael Siegrist |
| David Hassenzahl | Donna Vorhees |
| James Lambert | Felicia Wu |

2010 Program Committee

Rachel Davidson, President-elect and Chair

| | |
|--------------------|-------------------|
| Gary Bang | David Oryang |
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| Julie Fitzpatrick | Lisa Robinson |
| Kurt Frantzen | Paul Schlosser |
| Stanley Levinson | Stuart Shapiro |
| Steven Lewis | Thomas Seager |
| Igor Linkov | Ron White |
| Margaret MacDonell | |

SRA 2010 Student & International Award Winners

| | |
|---------------------------|--------------------------|
| Allen Catellier, Jennifer | Lizarazo , Jonathan |
| Bayramov, Azad | MacKenzie, Cameron |
| Bowles, Evan | Masinter, Alan |
| Cacciatore, Michael | Mensah, Yaw |
| Cardenas, Carlos | Orozco Restrepo, Gabriel |
| Donoso, Francisco Jose | Pan, Shih-Chun |
| Ferry, Josh | Pintar, Katarina |
| Fleishman, Lauren | Pita, James |
| Garcia, Sergio | Post, Kristianna |
| Gernand, Jeremy | Prpich, George |
| Grieger, Khara | Rokneddin, Keivan |
| Gruszczynski, Lukasz | Rush-Sirski, Andrea |
| Guimares Pereira, Angela | Sasaki, Katsunori |
| Hagan, Nicole | Shao, Kan |
| Hall, Ian | Tanaka, Yoko |
| Hamilton, Michelle | Thekdi, Shital |
| Ho, Wen-Chao | Trump, Benjamin |
| Hong, Tao | Vedomsk, Michael |
| Huang, Chongfu | Walchuk, Zachary |
| Huang, Ivy | Watanabe, Toru |
| Huang, Yin | Wilson, Muaror |
| Iverson, Steffan | Wolansky, Marcelo |
| Kailiponi, Paul | Wood, Matthew |
| Karvetski, Christopher | Wu, Chloe |
| Kellon, Delanie | Zan, Kun |
| Kirby-Straker, Rowena | Zarayskaya, Irina |

Meeting Events and Highlights

Registration Hours

Marriott Salt Lake City Downtown

Sunday, December 5 4:00 - 6:30 PM

Salt Palace Convention Center

Monday, December 6 7:00 AM - 5:30 PM

Tuesday, December 7 8:00 AM - 5:30 PM

Wednesday, December 8 8:00 AM - 5:30 PM

Conference Events/Council Meetings

Sunday, December 5

SRA Council Meeting

Noon-5:00 PM - Park City Room, Marriott

SRA Welcome Reception – (Cash Bar)

6:00-7:30 PM - Salon D, Marriott

Monday, December 6

Student & Young Professionals Mixer

5:00-6:00 PM - Deer Valley, Marriott

Poster Reception

6:00-8:00 PM - Salons A-F, Marriott

Tuesday, December 7

Awards Luncheon and Business Meeting

Noon-1:30 PM - Grand Ballroom E-H, Salt Palace Convention Center

Career Fair

5:00-6:30 PM - Room 151 A-C, Salt Palace Convention Center

SRA Council Meeting

6:30-10:00 PM, Snowbird/Brighton, Marriott

Wednesday, December 8

Plenary Luncheon

Noon-1:30 PM - Grand Ballroom E-H, Salt Palace Convention Center

T-Shirt Giveaway/Wine & Cheese Reception (Cash Bar)

5:00-6:00 PM - Registration Area, Salt Palace Convention Center

Specialty Group Meetings

Monday, December 6

12:00-1:30 PM - Salt Palace Convention Center

All Specialty Group Meetings will take place during lunch time on Monday, December 6, 2010. Pick up your box lunch at the registration desk and attend the meeting(s) of your choice.

12:05 - 12:30 PM - Business meeting Specialty Groups:

Dose-Response - 250A

Economics & Benefits Analysis - 250B

Security and Defense - 250D

Risk Communication - 250C

12:35-1:00 PM - Business meeting Specialty Groups:

Ecological Risk Assessment - 250F

Exposure Assessment - 251A/B

Risk Policy & Law - 251D/E

1:05 - 1:30 PM - Business meeting Specialty Groups:

Decision Analysis and Risk - 251C

Emerging Nanoscale Materials - 251F

Engineering & Infrastructure - 250D

Biological Stressors - 250A

Specialty Group Mixers

Tuesday, December 7

6:00 - 7:30 PM - Salt Palace Convention Center

DRSG, EASG, ERSG - Grand Ballroom E

ENMSG, EISG - Grand Ballroom F

EBASG, RPLSG - Grand Ballroom G

RCSG - Grand Ballroom H

BSSG - Grand Ballroom I

DARSG, SDSG - Grand Ballroom J

Key to Specialty Group Designations

BSSG = Biological Stressors

DARSG = Decision Analysis and Risk

DRSG = Dose-Response

EASG = Exposure Assessment

EBASG = Economics & Benefits Analysis

EISG = Engineering and Infrastructure

ENMSG = Emerging Nanoscale Materials

ERASG - Ecological Risk Assessment

RCSG = Risk Communication

RPLSG = Risk Policy and Law

SDSG = Security and Defense

Committee/Other Meetings

Monday, December 6

New Member and Fellows Breakfast

7:00-8:00 AM - *Salons A-D, Marriott*

All SRA Fellows as well as 2010 and 2011 New Members (badges with a New Member ribbon) are welcome to attend.

Publications Committee

7:00-8:00 AM - *Solitude, Marriott*

Regional Organizations (Chapters & Sections) Chairs Meeting

7:30-8:20 AM - *Brighton, Marriott*

Conferences and Workshops Committee

2:45-3:45 PM - *150C, Salt Palace Convention Center*

Tuesday, December 7

Grad Student Breakfast

7:00-8:00 AM - *Solitude, Marriott*

Specialty Group Chairs Breakfast

7:00-8:00 AM - *Deer Valley, Marriott*

Communications Committee

7:00-9:00 AM - *Brighton, Marriott*

Wednesday, December 8

Education Committee Breakfast

7:00-8:00 AM - *Alta, Marriott*

Refreshment Breaks will be provided in the
Registration/Exhibit Area
Monday through Wednesday
10:00-10:30 AM and 3:00-3:30 PM

Exhibition - Ballroom Foyer

Monday, December 6 Noon - 4:00 PM

Tuesday, December 7 9:45 AM - 4:00 PM

Wednesday, December 8 9:45 AM - Noon

Exhibitors

H. Steven Logsdon/Wildlife Artist

PO Box 4070

Silver City, NM 88062

575-388-8101

Wildlife jewelry.

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Risk Centre at Cranfield University

Bldg 56B, Risk Centre

Cranfield University Cranfield

Bedfordshire England MK43 0AL

The Risk Centre, at Cranfield University, provides world-class risk research and strategic support to government and the wider industry. Current research themes include strategic risk appraisal, weight of evidence assessments, organizational maturity, climate change, risk assessment of engineered nanomaterials and reliability assessment.

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Toxicology Excellence for Risk Assessment (TERA)

230 Montana Avenue, Suite 409
Cincinnati, OH 45211
513-542-7475; FAX: 513-542-7487
www.tera.org

TERA is a non-profit risk assessment organization dedicated to the best use of toxicity information for risk assessment. Information on key TERA projects and resources will be available, including risk databases (ITER, RiskIE) and training, the Alliance for Risk Assessment, assessments, and peer review.

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Contact: Meg Poehlmann,
poehlmann@tera.org

UPCOMING EVENTS

Dose-Response Assessment Boot Camp (February 7-11, 2011; Austin, TX): 5-day intensive, hands-on training in hazard characterization and dose-response assessment for human health risk assessments.

Contact: Patricia Nance, nance@tera.org

Beyond Science and Decisions: From Issue Identification to Dose-Response Assessment Workshop III (Spring 2011, Washington, DC area): Sponsored by 35+ different organizations, building on the theoretical suggestions of the NAS (2009) to develop practical dose-response techniques to advance the field of risk assessment.

Contact: Mike Dourson, dourson@tera.org

Visit our table at SRA!

WWW.TERA.ORG

Books on Display:

The MIT Press
55 Hayward Street
Cambridge, MA 01242
617-258-5764; FAX: 617-253-1709

The Innovator's Way: Essential Practices for Successful Innovation. 2010. *Peter J Denning, Robert P Dunham*. ISBN: 978-0-262-01454-0. List: \$29.95; Meeting price: \$20.97

Blowout in the Gulf: The BP Oil Disaster and the Future of Energy in America. 2010. *William Freudenburg, Robert Gramling*. ISBN: 978-0-262-01583-7. List: \$18.95; Meeting price: \$13.27

At War with the Weather: Managing Large-Scale Risks in a New Era of Catastrophes. 2009. *Howard C. Kunreuther, Erwann O. Michel-Kerjan*. ISBN: 978-0-262-01282-9. List: 58.00; Meeting price: \$40.60

The Resilient Enterprise: Overcoming Vulnerability for Competitive Advantage. 2007. *Yossi Sheffi*. ISBN: 978-0-262-69349-3. List: \$19.95; Meeting price: \$13.97

Operations Rules: Delivering Customer Value Through Flexible Operations. 2010. *David Simchi-Levi*. ISBN: 978-0-262-014742. List: \$29.95; Meeting price: \$20.97

Global Catastrophes and Trends: The Next Fifty Years. 2008. *Vaclav Smil*. ISBN: 978-0-262-19586-7. List: \$29.95; Meeting price: \$20.97

Palgrave Macmillan

175 Fifth Avenue

New York, NY 10010

The Geneva Papers on Risk and Insurance - Issues and Practice. *Patrick M. Liedtke*. ISBN: 1018-5895/EISSN: 1468-0440. List: \$134.00; Meeting price: \$104.00

The Geneva Risk and Insurance Review. *Keith J. Crocker, Schim Wambach*. ISBN: 1554-964X/EISSN: 1554-9658. List: \$579.00; Meeting price: \$417.00

Risk Management. *Denise Fischbacher-Smith, Dominic Elliott, Alan Irwin*. ISBN: 1460-3799/EISSN: 1743-4637. List: \$846.00; Meeting price: \$630.00

New This Year... New This Year... New This Year... New This Year... New This Year

SRA Career Fair

Career Fair, Tuesday, 5:00-6:30 pm

151A-C Salt Palace Convention Center

Finding the right job. Continuing education. Work-force training. Career advancement. It's a giant puzzle, but the career fair at this year's SRA Annual Meeting can help you put all the pieces together. During this event, job seekers can network with employers looking to fill vacancies as well as participate in on-site interviews. This will be your opportunity to show off your first impressions, resumes and get one-on-one time with local recruiters and employment resources.

Come dressed professionally, and bring along plenty of resumes and a winning attitude. Remember, this is an employer's first impression of you, so treat this event like you would a job interview.

Resumes and Job Opportunities

The Annual Meeting offers an opportunity to connect Jobs with Job Seekers. Please send your available-job postings via email to David Drupa at ddrupa@burkinc.com. If you would like to submit a blind resume, please request a form by emailing David Drupa at ddrupa@burkinc.com.

Job postings and blind resumes will be posted at the meeting and will be held at SRA headquarters for 6 months after the meeting.



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Workshops - Sunday, December 5

Full Day Workshops – 8:30 am – 5:30 pm

(Lunch is on your own, 12:30-1:30, other than as noted on particular workshop description)

WK 2: Benchmark Dose Modeling and Its Use in Risk Assessment – EPA's BMDS Version 2.1.2

Organizer: J. Allen Davis, US Environmental Protection Agency

\$300 onsite registration

This workshop will provide participants with interactive training on the use of the U.S. EPA's Benchmark Dose Software (BMDS), and its application to risk assessment. The course will provide an overview of the BMD process, including determination of data adequacy, model fitting and comparison, and selection of a benchmark response level. This workshop will cover all the BMD models available in the current version of BMDS as well as the new MS-COMBO model, which calculates multi-tumor composite risk values. Instruction will also be given in regard to additional changes that have been implemented in Version 2.1.2, including model input (expanded file lengths and use of spaces in file names) and output (plot editing and improved Excel export) features. This interactive training workshop in the use of BMDS will consist of a mix of instructor presentations and individual and group class activities. Attendees will work on examples from chemical assessments and learn how to use BMDS to prepare summary reports for insertion in their assessments. Questions and critical discussions of presentation material and class activities are highly encouraged. NOTE: Participants need to bring their own laptops to the workshop with the latest version of BMDS 2.1.2 installed (with necessary administrative rights). The latest version of the software can be found at: <http://epa.gov/ncea/bmds/>. To ensure students receive the maximum benefit from participating in the workshop, it is recommended that they examine the online training and tutorial materials prior to the workshop. Training and tutorial materials can be found at: <http://www.epa.gov/ncea/bmds/training/index.html>.

WK 3: Probabilistic Risk Analysis with Hardly Any Information

Organizer: Scott Ferson, Applied Biomathematics

\$300 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. The discussion addresses how defensible decisions can be made even when little information is available, and when one should break down and collect more empirical data and, in that case, what data to collect. When properly formulated, a probabilistic risk analysis reveals what can be inferred from available information and characterizes the reliability of those inferences. In cases where the available information is insufficient to reach dispositive conclusions, bounding probabilistic risk analysis provides a compelling argument for further empirical research and data collection. The presentation style of the tutorial will be casual and interactive. Participants will receive a booklet of the illustrations and numerical examples used during the tutorial. (NOTE: This workshop is also being offered on Thursday 9 December, see below.)

WK 5: Decision Analysis for Risk Analysts

Organizer: Gregory Parnell, USMA

\$250 onsite registration

Decision analysis is the appropriate operations research technique to help decision makers facing difficult decisions with multiple stakeholders, conflicting objectives, significant uncertainties, and complex alternatives. This workshop presents the fundamentals of decision analysis to help risk analysts understand a related discipline that offers important concepts and techniques that can be used by risk analysts to better meet the needs of their clients and key stakeholders. We present the methodology and art of single objective (usu-

ally net present value) and multiobjective decision analysis and introduce the philosophy of Value-Focused Thinking for creating value for customers that focuses on identifying stakeholder values, using values to generate new alternatives, and using values to evaluate the alternatives. Several decision analysis applications are presented including examples of the use of decision analysis and risk analysis concepts incorporated in an integrated analysis framework. In addition to the analytical concepts, the workshop compares three decision analysis approaches (analytic approach, decision conferences, and dialog decision process) to engaging decision makers and stakeholders.

WK 6: Improving Risk Governance: Stakeholder Involvement and Participation

Organizers: Ortwin Renn, Stuttgart University; Marie-Valentin Floring

\$275 onsite registration

The success with which risks are managed in society, in the world, depends on a complex system of risk governance. Not only does risk governance include what we traditionally define as ‘risk analysis’ and ‘risk management’ but it also includes of a range of decision makers, stakeholders, scientists and other experts, or members of the public and the roles they have on decisions throughout the process. Failures of risk governance can often be traced to failures to understand and respond to this ‘bigger picture.’ This workshop focuses on how best to involve stakeholders throughout the process. 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. Their framework was designed to provide a more comprehensive characterization of risk governance — one that builds on foundations of risk analysis and management as embodied in many in existing frameworks — and thereby to guide risk analysts and policy makers around common pitfalls that have been encountered before. The workshop will be a combination of lecture and interactive case studies, development of mock press conferences and other role-playing exercises, and feedback discussions. The cases studies will be draw from recent experiences of the presenters with respect to food and technology. It is designed to help workshop participants think through the issues involved in dealing with inclusive governance both in the design of programs for the governance of new risks and when faced with a crisis.

WK 8: Cumulative Risk Assessment Concepts, Methods and Resources

Organizer: Linda Teuschler, US Environmental Protection Agency

\$425 onsite registration

Public interest has been growing regarding the health effects of environmental exposures and cumulative impacts from multiple chemical and non-chemical (e.g., microbes, noise) stressors on communities. Initiating factors for a cumulative risk assessment (CRA) could include: contaminants in environmental media from multiple pollutant sources; environmental quality metrics, e.g., pollution levels; exposure metrics, including biomonitoring; public health effect metrics; and ecosystem impacts. CRA can be defined as an analysis, characterization, and possible quantification of the combined risks to human health or the environment from multiple agents or stressors. In addition, population and individual vulnerability factors are being recognized as important to consider in a CRA, such as diet/nutritional status, behaviors, genetic traits, socio-economic status, sensitivities, and psychosocial stress. Research efforts focus on multiple chemical and nonchemical stressors, environmental fate across exposure settings, and impacts on vulnerable communities. CRA integrates information across space and time, to produce a population-based risk picture and inform health protection. This workshop highlights concepts, methods, and resources for scoping and conducting a population-based CRA. A central theme is integrating exposure information and population characteristics during CRA planning and scoping based on initiating factors. Then, chemicals or non-chemical stressors are grouped by exposure and toxicity factors for risk evaluation and linked with population vulnerability factors to develop risk characterization information. Methods for estimating human health risks are discussed, including epidemiologic approaches and methods based on existing chemical mixtures risk assessment guidance and toxicological data. Teaching methods include lectures and hands-on exercises. NOTE: Participants are asked to bring a calculator.

WK 9: OFF-SITE FIELD TRIP: Living with the White Death – Managing Risk in Avalanche Country

Organizer: Jon Nepstad, Snowpit Technologies

\$180 onsite registration

The Wasatch Mountains on the outskirts of Salt Lake City are home to some of the most spectacular and treacherous avalanche terrain in North America. Past avalanches in these mountains have produced widespread destruction and loss of life on the highways and towns below. But today, this

natural hazard is tamed through a complex risk management network that includes real-time monitoring, forecasting, risk modeling, traffic management and explosive control. This workshop travels by bus to the town of Alta (elevation 8,200 feet), the birthplace of modern avalanche risk management and the battleground between emerging science and this natural hazard. Learn about the risk models, communication networks and forecasting systems aimed at protecting the town and highways. And learn about the methods, ranging from artillery, helicopter bombing and road closures used to keep the public safe. After our morning session indoors, enjoy lunch (on your own) at one of the many eateries at Snowbird Center and then join us for an enclosed aerial tram ride to the summit of Hidden Peak (11,000 feet) for spectacular views (weather permitting) of avalanche start zones and a first-hand look at how ski resorts control avalanche hazard within their boundaries, and the tools they use when the worst happens. NOTE: Portions of this field trip will take place outdoors in a mountain environment, and participants should come prepared with clothing and footwear suitable for walking on packed snow in cold and windy conditions. A release form is required to participate.

Half Day Morning Workshops – 8:00 am – Noon

WK 10: Use of Expert Elicitation to Inform Decision Making

Organizers: Aylin Sertkaya, ERG; Cristina McLaughlin, FDA/CFSAN/OSAS/DMS

\$300 onsite registration

If combined with any afternoon workshop: \$200/\$250

Decision makers must frequently rely on data or information that is incomplete or inadequate. Judgment, often from experts, then plays a critical role in the interpretation and characterization of those data. But how experts are selected and their judgments elicited matters – they can also strongly influence the opinions obtained and the analysis on which they rely. Several approaches to eliciting expert judgments have evolved. The workshop will cover topics ranging from expert recruitment, elicitation protocol design, different elicitation techniques (e.g., individual elicitations, Delphi method, nominal group technique, etc.) to aggregation methods for combining opinions of multiple experts. The role of expert elicitation and its limitations, problems, and risks in policy analysis will also be addressed. The workshop will include presentation of three case studies: 1) from EPA on using expert elicitation to determine the relationship between mortality and exposure to fine particulates; 2) a recent FDA study that evaluated the food safety hazards and preventive controls as-

sociated with transportation and holding of food commodities; 3) EPA's use of the Nominal Group Technique to rank research priorities for nano-TiO₂ and nanomaterials more broadly. All three presentations will include a discussion of the expert selection process; elicitation protocol development, elicitation technique utilized, and the various issues that arose before, during, and after the elicitation process and the manner in which they were resolved. More detailed information on the workshop, as well as related reading, will be posted on the SRA Economics and Benefits Analysis Specialty Group website: www.sra.org/ebasg and on <http://sites.google.com/site/2010sraeworkshop/>.

WK 11: Multi-Pathway Risk Assessment

Organizer: Stephen Zemba, Cambridge Env. Inc.

\$250 onsite registration

An introduction to multi-pathway risk assessment (MPRA) will be provided, covering both theory and practical implementation issues for human health and ecological risk assessment. MPRA is typically applied to air toxics emissions from combustion facilities, and is an important component of MACT residual risk determinations. A series of models is used to simulate pollutant transport and disposition in the environment, beginning with air dispersion and deposition (e.g., via AERMOD), followed by soil layer mixing, uptake by plants/vegetables, watershed loading analysis (including soil erosion), and food chain accumulation. MPRA is particularly relevant to assessing impacts of bioaccumulative pollutants such as mercury and polychlorinated dibenzo(p)dioxins and furans (PCDD/Fs). MPRA's are frequently based on very scant and uncertain data, e.g., emissions data from a single stack test, and transport factors derived from unrepresentative scenarios. The compounding and linking of models introduces large and complex uncertainties. Because little validation of MPRA methods has taken place, the careful consideration of these uncertainties is essential. The workshop will focus on the basics of MPRA theory, available regulatory guidance, and key factors involved in implementation, with special emphasis on issues relevant to mercury and PCDD/F. Discussion of pitfalls (e.g., models that violate mass conservation) will be included, as well as a case study involving mercury bioaccumulation in fish, in which departure from regulatory default assumptions to realistic parameterizations resulted in risk estimates differing by several orders of magnitude. The workshop will consist mostly of lectures and illustrative examples, but some time will be allocated to open-ended discussion.

WK 12: Managing Enterprise and Project Risks from a Systems Perspective

Organizer: C. Ariel Pinto, Old Dominion University

\$325 onsite registration

This workshop has the objective to develop understanding and skills on the basic framework for the modeling, assessment, analysis, and management of risks in the context of project and engineering enterprises. Topics to be discussed include, but are not limited to, introductions to risk and project management, engineering enterprise systems, a systems perspective on project goals and anti-goals, identifying and estimating project risks, and using expert evidence in risk estimation. Also discussed will be generalized processes for project risk management and engineering enterprise risk management, including the characterization of enterprise problem space and capability approach. There will be several short case studies for workshop participants to develop fundamental skills and generate insights.

Half Day Afternoon Workshops – 1:00 - 5:00 pm

WK 14: Risk Analysis: Fundamental Concepts, Applications and Controversies

Organizer: Darrell Donahue, University of Maine

\$280 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 two 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 of risk analysis as well as a number of 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.

WK 15: Introduction to Behavioral Economics

Organizer: Lisa Robinson, Independent Consultant, Newton, MA

\$300 onsite registration

If combined with any morning workshop: \$200/\$250

Behavioral economics is a large and rapidly growing field, with numerous implications for risk policy design and analysis. Within the Federal government, behaviorally-informed approaches to regulation are receiving significantly increased attention and emphasis. This workshop provides an introduction to behavioral economics for those who are particularly interested in its application to risk management, combining presentations from leading experts with opportunities for questions and discussion. We will begin by introducing the distinction between traditional and behavioral economics, discussing how the latter challenges the assumption that individuals act rationally and make decisions that maximize their welfare. Dr. Paul Slovic, who has conducted extensive research on these issues, will then describe the psychological foundations of behavioral economics in more detail. We will next introduce staff from key Federal agencies who will describe behaviorally-informed design and implementation of risk management strategies in different policy areas. The following session will consider the implications of behavioral research for assessing the benefits and costs of risk-reducing policies. We will conclude by summarizing the effects of behavioral economics on risk management decisions. More detailed information on the workshop, as well as related reading, will be posted on the SRA Economics and Benefits Analysis Specialty Group website: www.sra.org/ebasg.

WK 16: Introduction to Environmental and Health Aspects of Nanotechnology

Organizer: Jo Anne Shatkin, CLF Ventures, Inc.

\$400 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.

Thursday, December 9 Workshop – 8:30 am – 5:30 pm

WK 18: Probabilistic Risk Analysis with Hardly Any Information

Organizer: Scott Ferson, Applied Biomathematics

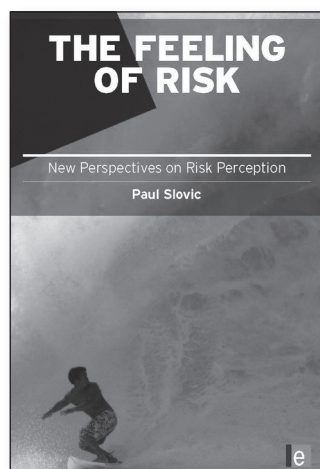
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See description for Workshop #3; this workshop is also offered Sunday; please identify your day choice when registering.

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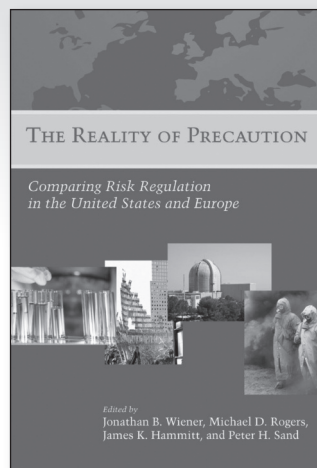
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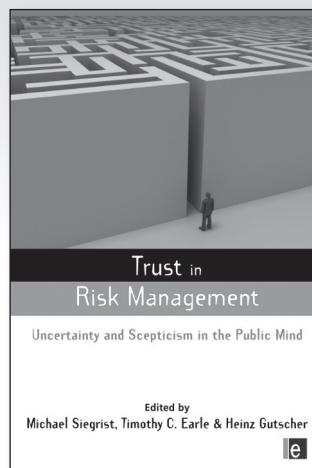


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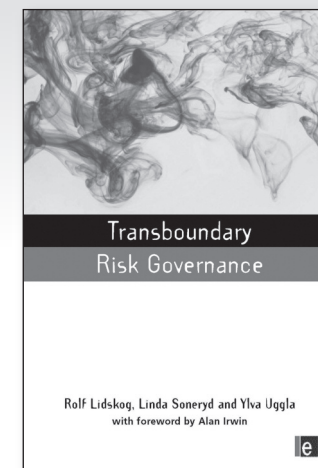
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PLENARY SESSIONS

All Plenary Sessions will be held in the Salt Palace Convention Center, Grand Ballroom A-D

Monday, December 6, 8:30-10:00 AM

“Strategies for Reducing Catastrophe Risks in the Face of Climate Change”

Moderator: Howard Kunreuther

Speakers: Scott Belden, William Hooke, Granger Morgan, Robert Muir-Wood

Tuesday, December 7, 8:30-10:00 AM

“The Analysis and Management of Financial Risk: What Happened and Where Do We Go from Here?”

Moderator: Jonathan Wiener

Speakers: Michael Mauboussin, Richard Zeckhauser

Wednesday, December 8, Noon-1:30 PM

“Impossible Dreams: Mt. Everest and Eradicating World Blindness”

Speaker: Geoffrey Tabin

EVENING EVENTS

SUNDAY - Welcome Reception, 6:00-7:30 pm, *Salon D, Marriott*

MONDAY - Poster Reception, 6:00-8:00 pm, *Salons A-F, Marriott*

This year’s meeting will feature one Poster Reception with food and cash bar.

During this time, attendees will have the opportunity to vote for the 5 Best Posters. Posters will be on display starting at noon and poster presenters will be at their posters for questions and discussion during the Reception. Don’t miss it!

WEDNESDAY - T-Shirt Giveaway/Wine & Cheese Reception (Cash Bar), 5:00-6:00 pm, *Registration Area, Salt Palace Convention Center*

| 10:30-11:30 AM 250A | 10:30 AM-Noon 250B | 10:30 AM-Noon 250C | 10:30 AM-Noon 250D | 10:30 AM-Noon 250F |
|---|---|--|--|---|
| M2-A Symposium: Analysis and the Policy Process <i>Chair: Adam Finkel</i> | M2-B Symposium: Decision Support Methods for Nanomaterial Risk Assessment and Risk Management Part 1 <i>Co-Chairs: J. Michael Davis, Thomas Seager</i> | M2-C Energy Futures <i>Chair: Frederic Boudier</i> | M2-D Symposium: Biologically-Based Dose Response Models-Cancer <i>Chair: Suresh Moolgavkar</i> | M2-E Symposium: Challenges & Opportunities at the Infra-Envi Nexus <i>Chair: Francis Royce</i> |
| 10:30 am M2-A.2 Regulatory quality from regulatory analysis <i>Williams RA, Ellig J</i> <i>Mercatus Center at George Mason University</i> | 10:30 am M2-B.1 Multi criteria decision making model based on probabilistic inversion: application to risk assessment of nanotechnology-enabled food products <i>Flari V, Neslo R, Chaudhry Q, Cooke R</i> <i>Food and Environment Research Agency, United Kingdom, University of Delft, the Netherlands, Resources for the Future, USA</i> | 10:30 am M2-C.1 Assessing public opinion of alternative energies: the role of cognitive associations in support for biofuels <i>Cacciatore MA, Brigham Schmuhl N, Binder AR*, Scheufele DA, Shaw BR</i> <i>University of Wisconsin-Madison</i> | 10:30 am M2-D.1 Clonal Expansion (CE) models in cancer risk assessment <i>Conolly RB</i> <i>US Environmental Protection Agency</i> | 10:30 am M2-E.1 Resilience of couple ecological-economic systems: biofuels <i>Seager TP, Mu D, Zhao F, Rao PSC</i> <i>Rochester Institute of Technology</i> |
| 10:50 am M2-A.3 Risk assessment and information quality: an empirical study of federal agency performance, 2010 update <i>Belzer RB</i> <i>Regulatory Checkbook</i> | 10:50 am M2-B.2 Bayesnets for nanomaterial risk assessment <i>Money ES, Reckhow KH</i> <i>Duke University</i> | 10:50 am M2-C.2 Public perceptions of climate change and energy futures: a national British survey <i>Pidgeon N, Spence A, Poortinga W, Venables D</i> <i>Cardiff University</i> | 10:50 am M2-D.2 BBDR models and the problem of low-dose extrapolation <i>Crump KS</i> <i>Louisiana Tech University</i> | 10:50 am M2-E.2 Modeling GHG emissions uncertainty and infrastructure decisions in utilizing biomass-based energy <i>Samaras C, Curtright AE, Willis H*, Ortiz DS, Johnson DR, Litovitz A</i> <i>RAND</i> |
| 11:10 am M2-A.4 Whither Lindblom: can analysis play a role in policymaking? <i>Shapiro S</i> <i>Rutgers University</i> | 11:10 am M2-B.3 Nominal group technique and research priorities for comprehensive environmental assessments of nanomaterials <i>Davis JM</i> <i>US Environmental Protection Agency</i> | 11:10 am M2-C.3 Informed public preferences for electricity portfolios with CCS and other low-carbon technologies <i>Fleishman LA, Bruine de Bruin W, Morgan MG</i> <i>Carnegie Mellon University</i> | 11:10 am M2-D.3 BBDR models for the assessment of risk from epidemiologic studies <i>Moolgavkar SH</i> <i>Exponent, Inc.</i> | 11:10 am M2-E.3 Designing multiple back-up energy systems for an unreliable power grid to evolve over time into a reliable and renewable microgrid <i>Mechtenberg AR</i> <i>University of Michigan</i> |
| | 11:30 am M2-B.4 A decision-directed approach to environmental risks of nanomaterials <i>Seager TP, Linkov I</i> <i>Rochester Institute of Technology</i> | 11:30 am M2-C.4 Risk communication and issue activation: the effect of risk perception and information effects on community members' actions toward a proposed uranium mine <i>Marlatt HL, Trumbo CW</i> <i>Colorado State University</i> | 11:30 am M2-D.4 Report of a workshop on dose-response approaches for nuclear receptor-mediated modes of action <i>Andersen MA, Budinsky RA*, Maier MA, Patterson J, Preston RJ, Rowlands JC, Willis AM</i> <i>The Hamner Institutes for Health Sciences, Dow Chemical, US Environmental Protection Agency, Toxicology Excellence for Risk Assessment</i> | 11:30 am M2-E.4 Can we get there with cleaner air? Temporal and spatial statistical analyses of urban transportation activities and ozone pollution <i>Gao HO</i> <i>Cornell University</i> |

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|--|---|---|---|--|
| <p align="center">10:30 AM-Noon <i>251A/B</i></p> <p align="center">M2-F Evolving Technologies for Risk Communication <i>Chair: David Bernube</i></p> <p>10:30 am M2-F.1 Hope vs. fear: risk analysis meets new social media <i>Thompson KM</i> <i>Kid Risk, Inc.</i></p> <p>10:50 am M2-F.2 The communication of located risks: mobile technologies as emerging communication channels <i>Fritth J</i> <i>North Carolina State University</i></p> <p>11:10 am M2-F.3 Evaluation metrics for risk communication <i>Drew CH, Anderson B, Beard SD, Brenner AT, Davis HL, Dilworth CH, O'Donnell CM, O'Fallon LR, Ryker SJ, Shipp SS</i> <i>National Institute of Environmental Health Sciences, Science and Technology Policy Institute</i></p> <p>11:30 am M2-F.4 TRADITIONAL or blogging? Risk communication and living organ donation <i>Siam - Asamoah D</i> <i>State University of New York at Buffalo</i></p> | <p align="center">10:30 AM-Noon <i>251C/D</i></p> <p align="center">M2-G Poster Platform: QMRA Applied to Food Safety <i>Chair: Donald Schaffner</i></p> <p>M2-G.1 Preliminary risk assessment for Salmonella in formulated dry foods <i>Schaffner DW</i> <i>Rutgers University</i></p> <p>M2-G.2 Quantitative risk assessment of shiga toxine producing escherichia coli in soft cheese <i>Perrin F, Sanaa M</i> <i>French Food Safety Agency, Direction of Nutritional and Sanitary Risk Evaluation</i></p> <p>M2-G.3 Risk of stillbirth due to maternal consumption of Listeria monocytogenes-contaminated fresh soft cheese in Hispanic pregnant women <i>Chan SH, Cousins AC, Domesle AR, Jones KL, Kissel JC, Meschke JS</i> <i>University of Washington</i></p> <p>M2-G.4 Modelling preparation and consumption of pork products <i>Swart AN, Nauta M, Evers E, Hald T, Snary E</i> <i>RIVM, VLA, Food-DTU</i></p> <p>M2-G.5 Development of a quantitative microbial risk assessment model for foodborne E. coli O157:H7 infection: the risk of consuming lettuce <i>Wu C, McColl S</i> <i>University of Waterloo</i></p> | <p>M2-G.6 Linking ocean process to human health risks from domoic acid in seafood using integrative bayesian models within a risk based framework <i>Griffith WC, Krogstad FTO, Vigoren EM, Faustman EM</i> <i>Institute for Risk Analysis and Risk Communication, University of Washington, Seattle</i></p> | <p align="center">10:30 AM-Noon <i>251E</i></p> <p align="center">M2-H Symposium: Plausibility and Risk <i>Chair: Heather Douglas</i></p> <p>10:30 am M2-H.1 Plausibility reasoning and nanotechnology futures <i>Selin C</i> <i>Arizona State University</i></p> <p>10:50 am M2-H.2 Beyond numbers: a historical perspective on probability and the emergence of plausibility <i>Guimarães Pereira A</i> <i>European Commission - Joint research Centre</i></p> <p>11:10 am M2-H.3 How do you know if a cluster is real when your dataset is tiny? <i>Ferson S, Siegrist J, Grimson R</i> <i>Applied Biomathematics</i></p> <p>11:30 am M2-H.4 Coherence, plausibility, and weight of evidence analysis <i>Douglas HE</i> <i>University of Tennessee</i></p> | <p align="center">10:30 AM-Noon <i>251F</i></p> <p align="center">M2-I Symposium: Approaches to Modeling Adaptive Adversaries for Risk Analysis <i>Chair: Heather Rosoff</i></p> <p>10:30 am M2-I.1 A comparative analysis of PRA and intelligent adversary methods for counter-terrorism risk management <i>Parnell GS, Merrick J</i> <i>United States Military Academy, Virginia Commonwealth University</i></p> <p>10:50 am M2-I.2 Elicitation of expert opinions about terrorist preferences <i>Bier VM, Wang M</i> <i>University of Wisconsin Madison</i></p> <p>11:10 am M2-I.3 Lessons learned from deployed game theoretic security applications <i>Tambe M, Jain M, Pita J*, Tsai J, Ordonez F</i> <i>University of Southern California</i></p> <p>11:30 am M2-I.4 Modeling the dynamic bidirectional influence of attack threat and countermeasure decisionmaking <i>John R, Rosoff H</i> <i>University of Southern California</i></p> |
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Specialty Group Meetings
All Specialty Group Meetings take place in the Salt Palace Convention Center

| | |
|--|---|
| 12:05 - 12:30 PM <i>Dose-Response - 250A</i> <i>Economics, Benefits Analysis - 250B</i> <i>Security and Defense - 250D</i> <i>Risk Communication - 250C</i> | 1:05 - 1:30 PM <i>Decision Analysis and Risk - 251C</i> <i>Emerging Nanoscale Materials - 251F</i> <i>Engineering & Infrastructure - 250D</i> <i>Biological Stressors - 250A</i> |
| 12:35-1:00 PM <i>Ecological Risk Assessment - 250F</i> <i>Exposure Assessment - 251A/B</i> <i>Risk Policy & Law - 251D/E</i> | |

| 1:30-3:00 PM 250A | 1:30-3:00 PM 250B | 1:30-3:00 PM 250C | 1:30-3:00 PM 250D | 1:30-3:10 PM 250F |
|--|--|---|--|--|
| M3-A Symposium: Thirty Years After the Benzene Decision: When will Risk Assessment Benefit Workers? Part 1 <i>Chair: Adam Finkel</i> | M3-B Symposium: Decision Support Methods for Nanomaterial Risk Assessment and Risk Management Part 2 <i>Chair: Ron White</i> | M3-C Industry Safety and Release Responsibilities <i>Chair: Ragnar Lofstedt</i> | M3-D Symposium: Salmonella in Low Moisture Foods: Understanding & Quantifying <i>Chair: Jane Van Doren</i> | M3-E Symposium: Reconstruction of Exposure & Dose <i>Co-Chairs: Dennis Paustenbach, Pam Williams</i> |
| 1:30 pm The importance of taking aim: lessons from setting the benzene workplace standard <i>Goldstein BD</i> <i>University of Pittsburgh Graduate School of Public Health</i> | 1:30 pm A review of frameworks and approaches for assessing environmental risks of nanomaterials <i>Grieger KD, Hansen SF, Linkov I, Baum A</i> <i>Technical University of Denmark, US Army Corps of Engineers</i> | 1:30 pm Can we still trust the regulator? Lessons from HSE's risk communication of onshore oil leaks <i>Bouder FB, Lofstedt RE</i> <i>Maastricht University</i> | 1:30 pm Salmonella in spices: risk profile <i>Van Doren JM, Gill V, Hammack TS, Kleinmeier D, Neil KP, Nsofor O, Parish M, Ziobro GC</i> <i>US Food and Drug Administration, US Centers for Disease Control and Prevention</i> | 1:30 pm Screening analysis of NHANES biomarker concentrations for evidence of socioeconomic disparities <i>Greco SL, Belova A, Riederer AM, Corales M</i> <i>ABT Associates</i> |
| 1:50 pm The Benzene decision and risk assessment at OSHA <i>Perry WG</i> <i>US Department of Labor</i> | 1:50 pm Discussant for decision support methods for nanomaterials assessment <i>von Stackelberg KE</i> <i>E Risk Sciences, LLP</i> | 1:50 pm Structuring citizen participation in technological risk management process and in framing Corporate Societal Responsibility within the French context <i>Merad M, Marcel F</i> <i>INERIS</i> | 1:50 pm Salmonella outbreaks associated with low-moisture foods in the United States, 1950 - 2007 <i>Mettee SL, Neil KP, Herman KM, Griffin PM</i> <i>Centers for Disease Control and Prevention</i> | 1:50 pm The role of exposure reconstruction in occupational human health risk assessment: current methods and a recommended framework <i>Sabmel J, Devlin K, Paustenbach DJ, Hollins D, Gaffney SH</i> <i>ChemRisk, Inc.</i> |
| 2:10 pm The role of risk assessment in protecting workers <i>Schulte PA, Sofge CW*</i> <i>National Institute for Occupational Safety and Health (NIOSH)</i> | 2:10 pm Panel Discussion | 2:10 pm The impact of the Globally Harmonized System of classification and labeling of chemicals (GHS) on the changing regulatory landscape of hazard communication <i>Le MH, Paustenbach DJ</i> <i>ChemRisk, LLC</i> | 2:10 pm Practical approaches to address salmonella in low moisture foods and a need for quantifying the risk <i>Chen Y</i> <i>Grocery Manufacturers Association</i> | 2:10 pm Potential health hazards associated with exposures to asbestos-containing drywall accessory products: a state-of-the-science assessment <i>Phelka AD, Finley BL</i> <i>ChemRisk</i> |
| 2:30 pm Reflections on the role of risk assessment at OSHA over the 40 year journey: has it been a big disappointment? <i>Paustenbach DJ</i> <i>ChemRisk LLC</i> | | 2:30 pm Public acceptance of nuclear power plant seismic safety <i>Oiso S</i> <i>Institute of Nuclear Safety System, Inc</i> | 2:30 pm Variability and uncertainty in pasteurization validation methods for low moisture foods <i>Marks BP</i> <i>Michigan State University</i> | 2:30 pm Derivation of margins of exposure from human biomonitoring data: a chemical industry perspective <i>Arnold SM, Bartels M, Burns C, Marty MS, Pitt J, Pottenger L, Saghir S, Ball N, Hollnagel H</i> <i>The Dow Chemical Company, Dow Europe GmbH</i> |
| | | | | 2:50 pm Final results of CDCs Los Alamos Historical Document Retrieval and Assessment (LAHDRA) project <i>Widner TE, Le MH*, Green JA</i> <i>ChemRisk, LLC</i> |

| 1:30-3:00 PM 251A/B | 1:30-3:00 PM 251C/D | 1:30-3:00 PM 251E | 1:30-3:00 PM 251F |
|--|---|--|--|
| M3-F Engaging the Public- Progress and Perspectives <i>Chair: Joseph Andrade</i> | M3-G Professional Development Roundtable for Students and Young Professionals | M3-H Decision Analysis Current State and Energy Ideas <i>Chair: Jeff Keisler</i> | M3-I Symposium: Modeling Developmental Toxicity Data <i>Chair: Allen Davis</i> |
| 1:30 pm M3-F.1 Engaging general publics in informal environments <i>Andrade JD</i> <i>University of Utah</i> | In the first annual Professional De- velopment Roundtable for Students and Young Professionals, a panel of leaders in the field will offer their pearls of wisdom about how to launch and sustain a successful ca- reer in Risk Analysis, followed by lots of time for questions and answers. The panel includes representatives from a range of disciplines and from academics, government, the private sector, and consulting: Elizabeth An- derson (Group Vice President for Health Sciences and Principal Scien- tist, Exponent); Ann Bostrom (As- sociate Dean of Research & Profes- sor, Daniel J. Evans School of Public Affairs, University of Washington); Jack Fowle (Deputy Director, Health Effects Division Office of Pesticide Programs U.S. Environmental Pro- tection Agency); and R. Jeffrey Lewis (Senior Scientific Associate, Exx- onMobil Biomedical Sciences, Inc., Epidemiology & Health Surveillance Section). | 1:30 pm M3-H.1 Rethinking total risk management <i>Ross RG, Lathrop JF</i> <i>Department of Homeland Security</i> | 1:30 pm M3-I.1 Application of the Rao-Scott trans- formation to account for intralitter correlation in the absence of indi- vidual animal data <i>Davis JA, Gift J</i> <i>US Environmental Protection Agency</i> |
| 1:50 pm M3-F.2 Risk and FACES: the Leonardo per- spective <i>Anter M, Andrade JD*</i> <i>The Leonardo</i> | | 1:50 pm M3-H.2 Multi-criteria decision analysis in en- vironmental sciences: ten years of ap- plications and trends <i>Huang I, Keisler J, Linkov I</i> <i>Massachusetts Institute of Technology</i> | 1:50 pm M3-I.2 Ins and outs of modeling develop- mental toxicity data - where are we and where would we like to be? <i>Faustman EM, Griffith WC</i> <i>University of Washington</i> |
| 2:10 pm M3-F.3 Adolescents and decisions: science centers as resources <i>Drews F</i> <i>University of Utah</i> | | 2:10 pm M3-H.3 On the use of participative risk gov- ernance: questioning scientific exper- tise <i>Merad M</i> <i>INERIS</i> | 2:10 pm M3-I.3 Use of PBPK Modeling to character- ize dose in the modeling of develop- mental toxicity data <i>Gentry PR</i> <i>ENVIRON International Corporation</i> |
| 2:30 pm M3-F.4 The more who die, the less we care: can we overcome psychophysical numbing through education? <i>Slovic P</i> <i>University of Oregon</i> | | 2:30 pm M3-H.4 The identification of harms <i>Decker DK</i> <i>Harvard University</i> | 2:30 pm M3-I.4 Use of developmental toxicity data in the derivation of an RfD/RfC: appli- cation of US EPA's Benchmark Mod- eling Software (BMDS) <i>Zhao J, Gift J</i> <i>US Environmental Protection Agency</i> |

| 3:30-5:00 PM 250A | 3:30-5:10 PM 250B | 3:30-5:10 PM 250C | 3:30-5:10 PM 250D | 3:30-5:10 PM 250F |
|---|--|---|---|--|
| M4-A Symposium: Thirty Years After the Benzene Decision: When will Risk Assessment Benefit Workers? Part 2 <i>Chair: Gary Marchant</i> | M4-B Ecological Risk Analysis in Action Part 1 <i>Chair: Kurt Frantzen</i> | M4-C Theoretical Constructs in Risk: Trust and Uncertainty <i>Chair: Janet Yang</i> | M4-D Symposium: Advances in Estimation of Risk from Foodborne Illness <i>Chair: Sandra Hoffman</i> | M4-E Symposium: Risk Analysis of System Independences <i>Co-Chairs: Joost Santos, Ariel Pinto</i> |
| 3:30 pm M4-A.1 An alternative approach to reduce workplace chemical exposure risks <i>Altemose B</i> <i>University of Medicine and Dentistry of New Jersey</i> | 3:30 pm M4-B.1 Hierarchical models for estimating risk of nitrous oxide emission in agricultural systems <i>Philibert AP, Loyce CL, Makowski DM</i> <i>INRA, AgroParisTech, France</i> | 3:30 pm M4-C.1 Web-enabled risk communication <i>Gresh D, Deleris L, Evans D, Gasparini L, O'Reilly E, Spaccasassi C</i> <i>IBM, University College Cork</i> | 3:30 pm M4-D.1 Estimating the social burden of foodborne illness in the US: cost-of-illness and QALY estimates by pathogen and food for eleven leading pathogens <i>Hoffmann SA, Batz M, Morris JG</i> <i>Resources for the Future, University of Florida</i> | 3:30 pm M4-E.1 Modeling and measuring network tolerance by Functional Dependency Network Analysis (FDNA) <i>Garvey PR</i> <i>The MITRE Corporation</i> |
| 3:50 pm M4-A.2 Advancing worker health and safety through chemicals policy <i>Wilson MP</i> <i>University of California, Berkeley</i> | 3:50 pm M4-B.2 Risks to biodiversity from climate change: a top-down approach <i>Hartley AJ, Foden W, Hemming D*</i> <i>Met Office Hadley Centre</i> | 3:50 pm M4-C.2 Communicating environmental health risk uncertainty - results of a systematic review of the literature <i>Jardine CG, Driedger SM, Given LM</i> <i>University of Alberta</i> | 3:50 pm M4-D.2 How much is in a recipe? Food commodity attribution of outbreak-related illnesses using two schemes for categorizing complex foods <i>Cole D, Ayers T, Herman K, Hoekstra R</i> <i>Centers for Disease Control and Prevention</i> | 3:50 pm M4-E.2 Interdependency modeling as a tool for analyzing resource sustainability <i>Walchuk ZM, Barker K</i> <i>University of Oklahoma</i> |
| 4:10 pm M4-A.3 The bad side of benzene <i>Wagner WE</i> <i>University of Texas School of Law</i> | 4:10 pm M4-B.3 Rapid decline of agro-biodiversity in Japan - another "market failure" <i>Seo K, Tabuchi E</i> <i>Aoyama Gakuin University</i> | 4:10 pm M4-C.3 Support for nuclear power and the perceived fairness of government, industry and university decision-makers <i>Besley JC, McComas KA</i> <i>University of South Carolina</i> | 4:10 pm M4-D.3 Use of epidemiologic profiling of foodborne outbreaks with unknown etiology in the attribution of foodborne illnesses to food commodities <i>Ayers TL, Hoekstra RM, Cole D</i> <i>CDC</i> | 4:10 pm M4-E.3 Risk of dependencies in systems development: the Ghana salt industry study <i>Mensab Y, Pinto CA</i> <i>ODU</i> |
| 4:30 pm M4-A.4 Waiting for the cavalry: the role of risk assessors in an enlightened occupational health policy <i>Finkel AM</i> <i>Penn Program on Regulation, University of Pennsylvania Law School</i> | 4:30 pm M4-B.4 Modernising the UK guidelines for environmental risk assessment and management: a case study approach <i>Gormley AM, Rocks SA, Pollard SJT</i> <i>Cranfield University</i> | 4:30 pm M4-C.4 Affect, psychological distance, and support for climate change initiatives <i>Hart PS, Stedman R, McComas K</i> <i>American University, Cornell University</i> | 4:30 pm M4-D.4 Regional variation in the value of statistical life: implications for cost of foodborne illness estimates <i>Scharff RL, Zan H</i> <i>The Ohio State University</i> | 4:30 pm M4-E.4 Integrating simulation with risk-based interdependency modeling to evaluate the consequences of an inland waterway port closure <i>MacKenzie CA, Barker K</i> <i>University of Oklahoma</i> |
| | 4:50 pm M4-B.5 Understanding risk and resilience in a small-scale coastal social-ecological fishery system <i>Wilson LJ, Pelot R, Charles A</i> <i>Dalhousie University, Saint Mary's University</i> | 4:50 pm M4-C.5 Climate Impacts and Risk assessment Framework (CIRF) <i>Hemming DL, Hartley A</i> <i>Met Office Hadley Centre</i> | 4:50 pm M4-D.5 Divergence among Canadian experts on human illness food attribution <i>Ravel A, Davidson VJ, Fazil A, Ruzante JM</i> <i>Public Health Agency of Canada, University of Guelph, University of Maryland</i> | 4:50 pm M4-E.5 Decision analysis tool for assessing hurricane impact on regional workforce productivity <i>Akhtar R, Santos JR</i> <i>GWU</i> |

| 3:30-5:10 PM 251A/B | 3:30-5:00 PM 251C/D | 3:30-5:00 251E | 3:30-5:10 PM 251F |
|--|---|--|--|
| M4-F Risk Governance and Climate Change <i>Chair: Joseph Arvai</i> | M4-G Symposium: Evaluating PBPK Models for Use in Risk Assessment <i>Chair: Paul Schlosser</i> | M4-H Symposium: Value of Information: What Has Been Done? <i>Chair: Igor Linkov</i> | M4-I Adaptive Adversary Risk Analysis, Resource Allocation, and Intelligence Optimization <i>Chair: Bob Ross</i> |
| 3:30 pm M4-F.1 Physical representation and proportional thinking on climate change <i>Dutt V, Gonzalez C</i> <i>Carnegie Mellon University</i> | 3:30 pm M4-G.1 Characterization of population distributions for PBPK model parameters <i>Clewell HJ</i> <i>The Hamner Institutes for Health Sciences</i> | 3:30 pm M4-H.1 Applications of value of information analysis: review of the literature since 1990 <i>Linkov I, Canis L, Zan K, Trump B, Keisler J</i> <i>US Army Engineer Research and Development Center</i> | 3:30 pm M4-I.1 A risk-based approach to the optimization of intelligence, surveillance, and reconnaissance activities <i>Gauthier Y, Shaw R</i> <i>Defence Research and Development Canada</i> |
| 3:50 pm M4-F.2 The role of public health agencies in protecting the public from climate-related risks to human health <i>Wilson RS, Syal S, Cranford JM, Lutz J</i> <i>The Ohio State University</i> | 3:50 pm M4-G.2 The importance of data evaluation for PBPK model development and risk assessment application <i>Evans MV</i> <i>US Environmental Protection Agency</i> | 3:50 pm M4-H.2 Linking VOI and MCDA: methodology and application to portfolio decisions <i>Zan K, Bickel JE, Keisler JM</i> <i>The University of Texas at Austin, University of Massachusetts Boston</i> | 3:50 pm M4-I.2 Resource allocation decisions against adaptive adversaries <i>Pita JA, Kiekintveld CD, Tambe M</i> <i>University of Southern California</i> |
| 4:10 pm M4-F.3 The role of emotion in global warming risk perceptions and policy preferences <i>Smith N, Leiserowitz A</i> <i>Yale University</i> | 4:10 pm M4-G.3 Enhancing the uptake of PBPK models by the regulatory community. The IPCS/WHO project on good PBPK modelling practice <i>Meek ME</i> <i>University of Ottawa, Canada</i> | 4:10 pm M4-H.3 Selecting nanomanufacturing technology: value of information analysis <i>Canis L, Seager T, Keisler J, Linkov I</i> <i>US Army Engineer Research and Development Center</i> | 4:10 pm M4-I.3 A scalable approach to adversary modeling for terrorism risk analysis <i>Streetman SS</i> <i>DHS Domestic Nuclear Detection Office</i> |
| 4:30 pm M4-F.4 Socioeconomic dimensions of geo-engineering and carbon sequestration: requirements for risk governance <i>Renn O</i> <i>Stuttgart University</i> | 4:30 pm M4-G.4 A strategy for efficiently evaluating (and improving) the applicability and quality of PBPK models <i>Schlosser PM</i> <i>US Environmental Protection Agency</i> | 4:30 pm M4-H.4 A decision model to select bucket dredge operating parameters in an estuary with value of information analysis <i>Schultz MT, Toll JE, Borronman TD, Tear L, Bridges TS</i> <i>US Army Engineer Research and Development Center</i> | 4:30 pm M4-I.4 Beyond probabilities times consequences: a strategic approach to terrorism risk management <i>Lathrop JF, Ross RG</i> <i>Innovative Decisions, Inc.</i> |
| 4:50 pm M4-F.5 Risk management in the era of public distrust <i>Lofstedt R</i> <i>Kings College London</i> | | | 4:50 pm M4-I.5 Adaptive adversary: factors & relationships that lead to terrorist decisions <i>Egell BC, Bebr JG</i> <i>Old Dominion University</i> |

6:00-8:00 PM

Salons A-I, Marriott

Poster Session

Decision Analysis

P.1 Critical criteria for development of the CHEMM online tool: expert models of its role in emergency response to hazardous chemicals
Kovacs D, Thorne S, Butte G, Chang F, Pakiam J, Hakkinen P

Decision Partners, LLC., US National Institutes of Health, National Library of Medicine

P.2 Statistical approach for background comparison in inorganics
Julius C, Marcum T, Luke N
CDM

P.3 Fuels transportation network design: minimization of risk associated to hazardous materials transportation
Cardenas CA, Lizgarazo JJ, Muñoz F
Andes University

P.4 An integrated knowledge state model for prioritizing complex multidisciplinary research portfolios
Masinter AM
Carnegie Mellon University

P.5 Comparative life cycle risk assessment of municipal solid waste end-of-life management methods in an urban setting
Scanlon KS, LaPuma PT
The George Washington University School of Public Health and Health Services

P.6 Use of a spatial decision support system to integrate GIS, environmental models, decision analysis tools, and stakeholder preferences
von Stackelberg KE, Zemba S, Lester R, Yatsalo B, Didenko V
E Risk Sciences, LLP, Cambridge Environmental, Inc., Obninsk State University

P.7 Framework for integrating human and animal data in chemical risk assessment
Lavelle KS, Schnatter AR, Travis KZ, Swain GM, Pallapies D, Money C, Vrijhof H, Priem P, Onyen L
ExxonMobil Biomedical Sciences, Inc., Syngenta, The Dow Chemical Company, Institute for Prevention and Occupational Medicine of the German Social, Exxon Mobil P

P.8 Risk-risk trade-off analysis on the substitution of the industrial cleaner
Kajihara H, Inoue K, Ishikawa Y, Lin BL, Kishimoto A
National Institute of Advanced Industrial Science and Technology

P.10 Evaluating the environmental burden of disease in Canada
Williams PRD, von Stackelberg K
E Risk Sciences, LLP

P.11 Estimating the water resources implications of producing unconventional gas from Pennsylvania's Marcellus Shale
Mitchell A, Casman E
Carnegie Mellon University

P.12 The wisdom of crowds 2.0: financial advice-seeking and decision making through online social networking
Steinhardt J
Syracuse University

P.14 A new approach to enterprise risk management: methodology development and pilot application
Camp JS, Abkowitz MD
Vanderbilt University

P.14B Tools for supporting environmental justice decisions
Brody T, Walts A, Bolka B, Knightly T, Delisio E, Maso C
US Environmental Protection Agency, Region 5, Chicago

Dose Response

P.15 Recent updates on the carcinogenicity of hexavalent chromium
Julius C, Marcum T, Luke N
CDM

P.16 Evaluation of concentration-response options for diacetyl in support of occupational risk assessment
Kohrman-Vincent MJ, Maier A, Parker A, Haber LT*
Toxicology Excellence for Risk Assessment (TERA)

P.17 An alternate mechanism of action for endocrine disruption effects of Bisphenol A
Iverson S, Berglund J
The Evergreen State College

P.18 Cumulative risk assessment for estrogenic chemicals
Bastaki M
The Evergreen State College

P.19 A risk assessment paradigm for tobacco smoke toxicants: segregation using a margin of exposure analysis.
Cunningham FH, Fiebelkorn S, Meredith C
Group R&D, British American Tobacco

P.20 Evaluation of the use of body weight as a covariate in the analysis of pubertal acquisition in rats
Parvez S, Teuschler LK, Narotsky MG, Simmons JE, Rice GE
NCEA US Environmental Protection Agency Cincinnati

P.21 Recommending a best-fitting model using an Excel-based BMDS "Wizard" for benchmark dose selection
Shapiro AJ, Henning CC, Lee RM
ICF International

P.22 Dose-response assessment of infection with *Leptospira* via skin route
Watanabe T, Ishibashi Y, Yamamoto K
The University of Tokyo, Tohoku Gakuin University

P.23 U.S. Environmental Protection Agency human health risk assessment colloquium
Fitzpatrick JW, Gallagher K
US Environmental Protection Agency

P.25 Report of a workshop: an evaluation of hypotheses for determining the carcinogenic potential of nickel-containing substances in the lung
Haber LT, Prueitt RL, Goodman JE, Thakali S
TERA, Gradient

P.26 Gender effects modify ozone exposure related to cardiovascular diseases mortality
Ho WC, Lin MH, Pan SH, Lin YS, Chen PC
China Medical University

P.27 An evaluation of the concentration-response relationship between ambient carbon monoxide and cardiovascular morbidity: integrating evidence from across scientific disciplines
*Johns D, Luben T, Buckley B, Long T**
US Environmental Protection Agency, National Center for Environmental Assessment, Research Triangle Park, NC

P.28 Health assessment of fine particulate exposure in Taiwan
Pan SH, Lin MH, Ho WC, Chen PC
China Medical University

P.29 Effects of ozone air pollution on cardiovascular mortality in highly urbanization city
Lin MH, Chen PC, Wu TN, Pan SC, Ho WC*
China Medical University

P.30 Probabilistic cancer risk assessment for dimethylarsinic acid from daily consumption of frying oil of fast food in Taiwan
*Lin M, Wu K-Y**
National Taiwan University

Ecological Risk

P.31 Extrapolating from extrapolations – where do we draw the (dose-response) line?
Bailey A, Stelljes M
SLR International Corp.

P.32 Resource use and valuation by Native Americans and others in the Northwestern United States
Burger J, Gochfeld M, Shukla S, Jeitner C, Pittfield T
Rutgers State University

P33 Resources, restoration, and attitudes toward natural resource damage assessment

*Burger J, Gochfeld M, Powers C
Rutgers State University*

P34 EPA risk assessment forum ecological oversight committee

*Martin LR, Gallagher K
US Environmental Protection Agency*

P35 Tiered, nationwide ecological risk screening for potential indirect effects of localized HCl air emissions in EPA's Risk Technology and Review (RTR) program

*McVey MM, Burch DF, Cleland JC, Derick E
ICF International*

P36 Predicting invasion success from species traits using machine learning techniques

*Philibert AP, Desprez-Loustau ML, Makowski D
INRA AgroParisTech, France*

P37 Integrated enteric disease surveillance, QMRA and ecosystem health: how does it all fit together? A Canadian perspective

Pintar KDM, Fazil A, Pollari FP, Walter-Toews D, Charron D, McEwen S, C-EnterNet Team Members

Public Health Agency of Canada, University of Guelph, International Development and Research Council

Economics & Benefits Analysis

P38 Optimizing the net social benefits for emission standards in Chilean thermoelectrical plants

Cifuentes LA, De la Maza C, Donoso FJ, Flores V, Hernandez MJ
Faculty of Engineering, Universidad Catolica de Chile*

P40 Policy-induced risk transfer of lead in Asia: an analysis using the combination of the computational general equilibrium model and the material flow model

*Makino R, Fuse M, Yamazaki M
National Institute of Advanced Industrial Science and Technology*

P41 Computable general equilibrium models to improve consequence estimation in bio-climatic risk analysis

*McDowell RM, Neeley AD
US Department of Agriculture*

P42 Integrating global climate models, epidemiological models, and general equilibrium economic models to simulate the biological and economic consequences of climate change on agro-ecosystem pests

*Sequeira RA, McDowell RM
US Department of Agriculture*

Engineering & Infrastructure

P43 Challenges in risk analysis of the impacts of climate change

*McNeill D, Daron J
Met Office Hadley Centre, London School of Economics*

Exposure Assessment: Applications and Analysis

P44 Considering potential health risks in the design of novel solid waste management facilities

*Zemba SG, Ames MR
Cambridge Environmental Inc.*

P45 Interpretation of benzene biomarkers of exposure for risk assessment

Arnold SM, Boogaard PJ, Hughes MF, O'Lone R, Price PS, Robison SH, Schnatter AR

The Dow Chemical Company, Shell International B.V., United States Environmental Protection Agency, ROT, ILSI Health and Environmental Sciences Institute, The Procter and Gamble Company, ExxonMobil Biomedical Sciences, Inc

P46 Legacies of mercury production and use in the Andes: the cases of Huancavelica and Potosí

Hagan N, Robins N, Hsu-Kim H, Morris M, Woodall G, Halabi S, Bacon A, Richter D, Vandenberg J

Oak Ridge Institute for Science and Education, North Carolina State University, Duke University, US Environmental Protection Agency, Office of Air Quality Planning and Standards, and National Center for Environmental Assessment

P47 Occupational exposure to diacetyl and potential health effects: a weight of evidence analysis

Hollins DM, Galbraith DA, Finley BL, Sahmel J
ChemRisk, Inc.*

P48 Recreational water exposure assessment using time-lapse photography

*Sunger NE, Haas CH
Drexel University*

P49 Atrazine in drinking water: comparison of measured and estimated peak concentrations vs. acute health benchmarks

*Shay E, Thuet K, Finley B
ChemRisk, LLC*

P50 Evaluation of PCB analytical methods to support risk assessment

Krupka EA, Kirchner SF, Julius C
CDM, Edison, New Jersey*

Exposure Assessment: Novel Problems and Approaches

P52 Results of an independent peer review of potential health risks from diversion of water from the Rio Grande as a source of tap water for the Santa Fe, New Mexico region

Widner TE, Le MH, Shay EC, Scott PK, Thuet KA, Keenan JJ
ChemRisk, LLC*

P54 A weight of evidence approach for selecting exposure biomarkers for biomonitoring

Zelenka MP, Barr DB, Nicolich MJ, Lewis RJ, Bird MG, Letinski DJ, Metcalf SW, O'Lone RB*

ExxonMobil Biomedical Sciences Inc, Emory University, COGIMAT, Agency for Toxic Substances and Disease Registry, ILSI Health and Environmental Sciences Institute

P55 Can dioxin sources be differentiated by congener profiles, and does it matter?

Zemba SG, Ames MR, Linkov I, Palma-Oliveira J

Cambridge Environmental Inc, Carnegie Mellon University and US Army Engineer Research and Development Center, University of Lisbon, Lisbon, Portugal

P56 Geostatistical estimation of soil PCDD/F TEQ using Sequential Gaussian Simulation and the aggregation of results in Midland, MI

*Tachovsky JA, Hans LC
ToxStrategies, Inc.*

P57 The integration of a community-wide human health risk assessment and exposure study (biomonitoring) in evaluating human health risks in a northern Canadian smelter community

*Safruk AM, Sigal EA, Jackson B, Pinsent C
Intrinsic Environmental Sciences Inc, Canada, Goss Gilroy Inc., Canada*

Risk Communication: Natural Hazardous Health and Transportation and Gaming

P58 Exploring attributions and emotional reactions in processing narratives about obesity

*Kim HK, Bartolo D, Niederdeppe J
Cornell University*

P59 Perceived harm, use ideation, and substance abuse progression among U.S. adolescents

*Lee LK
Amiral Consulting Group*

P60 A measure to reduce public anxiety about hazards

*Nakayachi K
Doshisha University*

P61 Do map features convey uncertainty for modeled cancer risk from air pollution? Assessing influence on risk beliefs and the ambiguity of risk beliefs

*Severtson DJ
University of Wisconsin-Madison*

P63 Ethnicity, risk perception, and self-protective behavior for West Nile virus

*Trumbo C, Zielinski-Gutiérrez E, Harper R, Kronauge C, Evans S
Colorado State University, Fort Collins, Centers for Disease Control and Prevention, Weld County Department of Health and Environment*

P.64 Weather forecasters' schemas and their construction of forecast messages

Demuth JD
Colorado State University, NCAR

P.65 Seismic risk perception, planning, and management in North American seaports

Scharles T, Bostrom A, Reimann-Garretson L, Rix G*
University of Washington

P.66 Seeking risk information: using the RISP model to explore risks with indeterminate behaviors.

Scherer CW, Yuan C, Levitan L
Cornell University

P.67 Analyzing risk communications and decision scenarios: a case study addressing very light jets impacts on the emergent private air travel industry

Sterling D, Krishen L
Futron Corporation

P.68 Imagining public engagement

Besley JC
University of South Carolina

P.70 A serious game for eliciting (and possibly shaping) risk perceptions

Jiang M, McGill WL
The Pennsylvania State University

P.71 Maximizing purposive gain in a serious gaming context

Cao Y, McGill W
College of Information Sciences and Technology, PSU

Security and Defense: Nuclear Nonproliferation

P.72 Nuclear forensics threat risk assessment

Bayramov AA
Institute of Physics Azerbaijan National Academy of Sciences

Miscellaneous

P.74 A review of headway and impact of risk guide and code in China recently

Hsu HX
Risk Management of Willis Insurance Broker, China

P.75 Safety norms of the society, a group of companies and a specific unit

Thedeen T
KTH

P.76 Corporate innovation system based on higher school: the efficiency is higher, the risk is below

Zarayuskaya IM
Russian State University for Innovation Technologies and Business

Current Events/Works-in-Progress

P.78 Establishment of the Korean tolerable daily intake of bisphenol

A based on risk assessments by an expert committee
Choi CW, Jeong JY, Hwang MS, Jung KK, Lee HM, Lee KH
National Institute of Food and Drug Safety Evaluation

P.79 Prediction of asbestos concentrations in air based on a drop test and cost-benefit analysis on countermeasures for health risk

Fujinaga A, Fujikawa Y, Hiraki T, Nakatsubo R
Osaka Prefectural College of Technology

P.80 Uncertainty, probability and robust preferences

Ben-Haim Y
Technion-Israel Institute of Technology

P.81 The Climate Perception project: Testing the effect of local climate on global warming risk perceptions

Howe PD
Pennsylvania State University

P.82 Prevention and early detection on the road: applying the risk information seeking and processing model to health information roadshows

Lundell HC
Cornell University

P.84 Risk – Cost – Benefit (RCB) selection of optimum early warning technologies

Kizil GV, Bye A
The Minerals Industry Safety and Health Centre, SMI - The University of Queensland, Australia

P.85 Risk assessment in intake from drinking water of per-fluorinated compounds

Tetsuji N, Toshinari S, Akihiko H
National Institute of Health and Sciences

P.86 Cost of equity in Homeland Security Resource Allocation in the face of possible non-strategic attackers

Shan X, Zhuang J
University at Buffalo

P.87 Generic Hockey-Stick model performs as well or better than USEPA Benchmark Dose methodology

Bogen KT
Exponent

P.88 The aspect of climate change in risk assessments of contaminated land

Augustsson A, Filipsson M, Berghäcke B, Öberg T
Linnaeus University

P.89 Spatial risk perception in dynamic hazard events

Klockow KE
University of Oklahoma

P.90 Spatial variation of ambient formaldehyde and acetaldehyde: implications for exposure assessment

Evans AM, Stuart AL
US Environmental Protection Agency, National Center for Environmental Assessment, OH, University of South Florida

P.91 Death risk attributable to motorized vehicle traffic in Chile

Jiménez R, Bronfman N
Andres Bello University

P.92 Risk assessment of mesothelioma among electricians

Peterson MK, Bailey LA, Dodge DG, Goodman JE, Valberg PA
Gradient

P.93 Effects of affective valence of rare events on overestimation of frequency judgment

Kugihara N
Osaka University

P.94 Climate change: a risk that can be compensated to be acceptable?

Gutierrez VV
Universidad Diego Portales and Pontificia Universidad Catolica de Chile

P.95 The curiously understudied toxicity of nanowires: framing and preliminary results

Philbrick M
University of California, Berkeley

P.96 Improving probability impact diagram matrices using multiple criteria decision analysis tools

Oliveira MD, Bana e Costa CA, Figueiredo MS
Centre for Management Studies of Instituto Superior Técnico, Technical University of Lisbon, Portugal

P.97 A new methodology for determining efficient routes for paved street sweeping system using GIS and graph theory

Meneses V, Alvarez P, Blazquez C*
Andres Bello University

P.98 A real-time data fusion framework for adaptive adversary modeling and risk analysis

Osidele O, Mobanty S
Southwest Research Institute

P.99 Potential mechanisms of environmental chemical-induced steatosis

Kaiser JP, Wesselkamper SC
Oak Ridge Institute for Science and Education, US Environmental Protection Agency

P.100 Use of risk assessment in an invasive species program

Ting D, Eya B, Fan A
California Environmental Protection Agency

P.101 An interactive web-based approach to risk assessment for resource efficiency and public health protection: State Environmental Agency Risk Collaboration for Harmonization (SEARCH)

*Effio D, Kroner O, Maier A, Hayes B, Willis A**
Consortium of Eastern Ohio Masters of Public Health, Toxicology Excellence for Risk Assessment (TERA), Indiana Department of Environmental Management

P.102 Public perceptions of carbon capture and storage in Canada: results of a national survey

*Boyd AD, Einsiedel EF
University of Calgary*

P.103 In the eye of the beholder: perceptions of wildlife disease risks

*Evensen DTN
Cornell University*

P.104 The effects of data selection on arsenic cancer slope direction and magnitude

*Lamm SH, Robbins S, Chen RS, Lu J, Feinleib M
Consultants in Epidemiology and Occupational Health, LLC, Georgetown University, Johns Hopkins University-Bloomberg School of Public Health, American University*

P.105 The effect of disinfection by-products, water source, and disinfection treatment on fetal growth and preterm delivery in Massachusetts

*Wright JM, Rivera-Núñez Z
US Environmental Protection Agency*

P.106 Inhalation and dermal exposure to trihalomethanes during and after showering

*Huang A-T, Nuckols J, Beane-Freeman L, Backer L, Blount B, Wilkes C, Branch R, Gordon S, Silva L, Cantor K
Occupational & Environmental Epidemiology Branch, Division of Cancer Epidemiology and Genetics, National Cancer Institute*

P.107 Decisions in disaster recovery operations: a game theory perspective on actor cooperation, communication, and resource utilization

*Coles JB, Zhuang J
University at Buffalo, The State University of New York*

P.108 STENOSIS.....a risk that can be avoided?

*Cabrera V
Universidad Diego Portales*

P.109 Qualitative vs. quantitative data quality objectives: what should reasonable people who are not statisticians do?

*Butler KM
McDaniel Lambert, Inc.*

P.110 Monitoring of lead and cadmium in agricultural products collected from the Korean market

*Chang EJ, Park SH, Jeong JS, Joo IS, Yoon HS, Sohn YW
Korea Food and Drug Administration*

P.111 Aflatoxin and population attributable liver cancer risk: Insights from biomarkers in multiple epidemiological studies.

*Liu Y, Wu F
University of Pittsburgh*

P.112 An independent expert review panel of a community-wide human health risk assessment for a northern canadian smelter community

*Patterson J, Willis A, Dourson M
Toxicology Excellence for Risk Assessment (TERA)*

P.113 Comparing resale prices and total cost of ownership for gasoline, hybrid and diesel passenger cars and trucks

*Gilmore EA, Lave LB
Engineering and Public Policy, Tepper School of Business, Carnegie Mellon University*

Don't Miss This!

Come to a book signing with **Paul Slovic**
during the Poster Reception
Monday, December 6th, 6:00 – 8:00 PM
Marriott, Salons A-I

| 10:30 AM-Noon 250A | 10:30 AM-Noon 250B | 10:30 AM- Noon 250C | 10:30 AM-Noon 250D | 10:30 AM-Noon 250F |
|---|--|---|---|---|
| T2-A Symposium: Health Impact Assessment, a Powerful Tool for Policy Matters, Who Needs It? How Should It be Used? <i>Chair: Wilbelmine Miller</i> | T2-B Symposium: Food Applications of Engineered Nanomaterials Part 1 <i>Chair: Nancy Rachman</i> | T2-C Households and Farms: Drinking Water and Soil <i>Chair: Louie Rivers</i> | T2-D QMRA's of Salmonella in Pork <i>Chair: Andrew Hill</i> | T2-E Response to Natural Disaster <i>Chair: Ariel Pinto</i> |
| 10:30 am T2-A.1 Health Impact Assessment: contextualized information for policy makers <i>Miller WD</i> <i>George Washington University</i> | 10:30 am T2-B.1 Approaches to nano study comparability: challenges and actions <i>Canady R</i> <i>Center for Human Health Risk Assessment, ILSI RF</i> | 10:30 am T2-C.1 The influence of proximity-based hazard on risk beliefs, emotion, and risk monitoring and mitigation intentions: comparing modeled proximity-based hazard to the effects of distance and hazard amount <i>Severtson DJ</i> <i>University of Wisconsin-Madison</i> | 10:30 am T2-D.1 Modelling of salmonella dynamics in the pig slaughterhouse <i>Swart AN, Evers E, Simons RRL, Hill AA, Hald T</i> <i>RIVM</i> | 10:30 am T2-E.1 Expert Models of USACE flood risk management: alignment of USACE planner and engineer Mental Models <i>Wood MD, Linkov I, Bridges T, Kovacs D, Thorne S, Butte G</i> <i>Carnegie Mellon University, US Army Corps of Engineers Environmental Laboratory, Decision Partners, LLC</i> |
| 10:50 am T2-A.2 Divergence and convergence in the evolution of HIA practice in the US <i>Cole BL</i> <i>University of California, Los Angeles School of Public Health</i> | 10:50 am T2-B.2 Critical evaluation of scientific literature on the oral toxicity of nanomaterials <i>Magnuson BA</i> <i>Cantox Health Sciences Intl</i> | 10:50 am T2-C.2 Contaminant mixtures in source water from public-supply wells in the United States <i>Toccalino PL, Norman JE</i> <i>US Geological Survey</i> | 10:50 am T2-D.2 A quantitative microbiological risk assessment for salmonella in pigs for individual EU member states <i>Snary EL, Simons RRL, Swart AN, Vire H, Domingues AR, Hald T, Evers E, Tennant J, Kelly L, Hill AA</i> <i>Veterinary Laboratories Agency, National Institute for Public Health and the Environment (RIVM), National Food Institute, Technical University of Denmark</i> | 10:50 am T2-E.2 Defending and attacking networks subject to traffic congestion <i>Bier V, Hausken K</i> <i>University of Wisconsin, Madison, University of Stavanger, Norway</i> |
| 11:10 am T2-A.3 Health Impact Assessment as a tool to inform climate change policy: the broad health impacts of cap and trade regulation in California <i>Richardson MJ</i> <i>California Department of Public Health</i> | 11:10 am T2-B.3 Environmental pathways of exposure to ENM in food <i>Sbatkin JA</i> <i>CLF Ventures</i> | 11:10 am T2-C.3 Rural Nevada: the influence of vulnerability on risk perception within the context of climate change <i>Safi A, Smith Jr. W, Zhongwei L</i> <i>University of Nevada Las Vegas</i> | 11:10 am T2-D.3 An analysis of potential on-farm and abattoir interventions to reduce human salmonellosis in EU member states attributable to pig meat consumption <i>Hill AA, Swart A, Simons RRL, Kelly L, Hald T, Evers E, Snary EL</i> <i>Veterinary Laboratories Agency, National Institute for Public Health and the Environment (RIVM), National Food Institute, Technical University of Denmark</i> | 11:10 am T2-E.3 Imputation models for use in hurricane building-risk analysis <i>Liu Z, Pita GL, Francis R, Mitrani-Reiser J, Guikema SD, Pinelli JP</i> <i>Johns Hopkins University, Florida Institute of Technology</i> |
| 11:30 am T2-A.4 Health impact assessment of the Port of Oakland - moving beyond health risk assessment <i>Seto EYW</i> <i>University of California, Berkeley</i> | 11:30 am T2-B.4 Assuring the safety of engineered nanomaterials in food: meeting the scientific, regulatory and risk communication challenges <i>Rachman NJ</i> <i>Grocery Manufacturers Association (GMA)</i> | 11:30 am T2-C.4 Soil management in the agroecosystem: the role of knowledge, risk perception, and self-efficacy <i>Ferry JE, Wilson RS</i> <i>The Ohio State University</i> | 11:30 am T2-D.4 A biotracing model of Salmonella in the pork production chain <i>Smid JH, Havelaar AH, Heres L, Hoek A, Swart A, Pielaat A</i> <i>National Institute for Public Health and the Environment of the Netherlands</i> | 11:30 am T2-E.4 Resource allocation for regional hurricane risk mitigation planning <i>Legg MN, Davidson RA*, Nozick LK</i> <i>University of Delaware, Cornell University</i> |

| 10:30 AM-Noon 251A/B | 10:30 AM-Noon 251C/D | 10:30 AM-Noon 251E | 10:30 AM-Noon 251F |
|--|---|--|--|
| T2-F Symposium: Communicating Evidence for Risk Characterization <i>Chair: Peter Wiedemann</i> | T2-G Novel Approaches in Dose Response <i>Chair: Mitch Small</i> | T2-H Symposium: Emerging Contaminants: Implementing Solutions <i>Chair: Andrew Rak</i> | T2-I Symposium: Innovations in Benefit Cost Analysis <i>Chair: Richard Zerbe</i> |
| 10:30 am T2-F.1 Communicating conflicting evidence for risk assessment <i>Wiedemann P, Schuetz H, Boerner F</i> <i>ITAS KIT Karlsruhe</i> | 10:30 am T2-G.1 Models and mechanisms of dose-re- sponse thresholds for particulate and nanoparticle-induced inflammatory lung diseases and lung cancer <i>Cox T</i> <i>Cox Associates, University of Colorado</i> | 10:30 am T2-H.1 Managing emerging contaminant risks: plans & progress <i>Yaroschak PJ</i> <i>Office of the Deputy Under Secretary of Defense (I&E)</i> | 10:30 am T2-I.1 Principles and standards for the bene- fit-cost analysis of public safety <i>Farrow S, Viscusi WK</i> <i>UMBC, Vanderbilt University</i> |
| 10:50 am T2-F.2 Communicating unclear risk through the evidence map: results of a Dutch experimental study <i>van Wingerden AM, Kuttischreuter M,</i> <i>Schütz H</i> <i>Centre for Risk and Safety Perception</i> <i>(iCRiSP), University of Twente</i> | 10:50 am T2-G.2 Modeling the infectious effect of multiple doses of scrapie agent <i>Huang Y, Haas CN</i> <i>Drexel University</i> | 10:50 am T2-H.2 Military anticipation of sulfur hexa- fluoride (SF ₆) regulations to protect climate: a case study in proactive re- duction <i>Rak A, Faramarzi A, Simmons M, Vogel</i> <i>CM</i> <i>Noblis</i> | 10:50 am T2-I.2 The quality and use of regulatory analysis: a new evaluation and data set <i>Ellig J, Morrall J</i> <i>Mercatus Center George Mason University</i> |
| 11:10 am T2-F.3 Testing evidence maps: results from a series of experiments <i>Boerner F, Schuetz H, Wiedemann P</i> <i>Kassel University</i> | 11:10 am T2-G.3 Value of information in toxicity study experimental design for benchmark dose estimation <i>Shao K, Small M</i> <i>Carnegie Mellon University</i> | 11:10 am T2-H.3 Transitioning to lead-free electrical and electronic equipment: unintent- ed consequences and potential im- pacts to the Department of Defense <i>Scanlon KA, McDonald S</i> <i>Concurrent Technologies Corporation</i> | 11:10 am T2-I.3 Behavioral economics and benefit- cost analysis <i>Robinson LA, Hammitt JK</i> <i>Independent Consultant, Harvard Univer- sity</i> |
| 11:30 am T2-F.4 Communicating scientific uncertain- ties to policy makers and decision makers: a two-way road <i>Flari V, Maule J, Hart A</i> <i>Food and Environment Research Agency,</i> <i>Defra, UK, University of Leeds, UK</i> | 11:30 am T2-G.4 A novel framework for leukemia risk assessment using human bone mar- row cells <i>Sasaki K, Imamura H, Nakayama A,</i> <i>Yoneda M, Morisawa S</i> <i>Kyoto University</i> | 11:30 am T2-H.4 Nanotechnology: dynamic risk man- agement for an evolving science <i>Bass N</i> <i>USAPHC</i> | 11:30 am T2-I.4 Commonalities in benefit cost analy- sis: a review of principles and stan- dards for treatment of risk <i>Davis TB, Zerbe RO</i> <i>University of Washington</i> |

| 1:30-2:30 PM 250A | 1:30-3:00 PM 250B | 1:30-3:00 PM 250C | 1:30-3:10 PM 250D | 1:30-3:00 PM 250F |
|---|---|--|--|---|
| T3-A International Approaches to Risk <i>Chair: Jennifer Kuzma</i> | T3-B Symposium: Food Applications of Engineered Nanomaterials Part 2 <i>Chair: Linda Abbott</i> | T3-C Examining Risk Perception and Communication in the Context of Aquatic Environments <i>Chair: Josh Ferry</i> | T3-D Special Methods Applied to Public Health <i>Chair: Mark Powell</i> | T3-E Issues in Critical Infrastructure <i>Chair: Jim Lambert</i> |
| 1:30 pm T3-A.1 Scientific expertise and adjudication in the WTO practice - mapping complex relationship <i>Gruszczyński LA</i> <i>Public University</i> | 1:30 pm T3-B.1 Framing hazard characterization for gastrointestinal ecosystems <i>Coleman ME</i> <i>Coleman Scientific Consulting</i> | 1:30 pm T3-C.1 The importance of addressing risk perception and risk communication in contaminated sediment remediation projects <i>Sparrevik M</i> <i>Norwegian Geotechnical Institute</i> | 1:30 pm T3-D.1 Considering the food safety impact of sampling plans <i>Powell M</i> <i>US Department of Agriculture</i> | 1:30 pm T3-E.1 Sparse data analysis using hierarchical Bayesian models with aspect-level clustering <i>Guo Z</i> <i>The Center for Risk Management of Engineering Systems, University of Virginia</i> |
| 1:50 pm T3-A.2 The role of science in risk management regulation in the EU: licensing and supervision of medicinal products <i>López-Jurado FB</i> <i>University of Navarra</i> | 1:50 pm T3-B.2 Characterizing uncertainty: insights from naturally occurring nanoscale structures in food and other lines of evidence <i>Abbott, LC</i> <i>US Department of Agriculture</i> | 1:50 pm T3-C.2 Integrating multiple lines of evidence for risk evaluation <i>Liu C, Lavell J, Allen M, Wakeman J</i> <i>CDM</i> | 1:50 pm T3-D.2 Supply of food safety in markets with imperfect information and under competing inspection schemes (risk mitigation strategies) <i>Mojduszka E, Schaub J</i> <i>US Department of Agriculture</i> | 1:50 pm T3-E.2 Quantification of the risk function from system vulnerability and resilience through Bayesian analysis <i>Andrijać E, Guo Z, Haimes YY</i> <i>University of Virginia</i> |
| 2:10 pm T3-A.4 A proposal for the regulation of occupational exposure to nanomaterials <i>Guidotti TL</i> <i>National Medical Advisory Services</i> | 2:10 pm T3-B.3 Emerging technologies - emergent risks: separating the wheat from the chaff <i>Maynard AD</i> <i>University of Michigan</i> | 2:10 pm T3-C.3 Mental models of aquaculture: implications for risk communication <i>Schlag AK</i> <i>King's College London</i> | 2:10 pm T3-D.3 Integrating economic theory and geographic information systems in examining environmental, occupational and food safety considerations for cultivating fresh produce on the Virginia Eastern Shore <i>McLaughlin CF, Acuna Mohr B, Estrin AJ</i> <i>US Food and Drug Administration</i> | 2:10 pm T3-E.3 Risk as a basis for determining sustainable development priorities: a model for setting sustainable development targets and standards <i>Amekudzi A</i> <i>Georgia Institute of Technology</i> |
| | 2:30 pm T3-B.4 Considering the future: panel discussion from sessions 1 and 2 <i>Rachman NR</i> <i>Grocery Manufacturers Association (GMA)</i> | 2:30 pm T3-C.4 The role of the mass media in encouraging environmental behavior change: lessons in social marketing and environmental risk communication <i>Dalrymple KE, Shaw BR, Brossard D</i> <i>University of Wisconsin-Madison</i> | 2:30 pm T3-D.4 An innovative agent-based model for transmission of contamination in childcare centers <i>Bowles EA, Mokhtari A, Todd E, Lapinski M</i> <i>North Carolina State University</i> | 2:30 pm T3-E.4 Improving infrastructure protection strategies through modeling trust in the risk analysis framework <i>Vedomsky MA, Cronther KG</i> <i>University of Virginia</i> |

| 1:30-3:00 PM 251A/B | 1:30-3:00 PM 251C/D | 1:30-3:00 PM 251E | 1:30-3:00 PM 251F |
|---|--|--|--|
| T3-F Assessment, Communication and Perception of Nanotechnology Risk <i>Chair: Margaret MacDonell</i> | T3-G Symposium: Beyond Science and Decisions <i>Chair: Lynne Haber</i> | T3-H Crashes, Wrecks, & Emergencies Part 1 <i>Chair: PK Kailiponi</i> | T3-I Symposium: All-Hazards Risk Analysis and Other Recent Advances in Homeland Security Risk Management <i>Co-Chairs: Steve Bennett, T. Seagert</i> |
| 1:30 pm T3-F.1 Emerging technologies and risk analysis <i>Berube DM</i> <i>North Carolina State University</i> | 1:30 pm T3-G.1 The case for both individual and population toxicity thresholds <i>Becker RA</i> <i>American Chemistry Council</i> | 1:30 pm T3-H.1 Risk-based closure following a release of Conosol 260 <i>Sager SL, Pinnix A, Clarkson JR, Atkins M</i> <i>ARCADIS US, Inc., CSX Transportation</i> | 1:30 pm T3-I.1 To be or not to be: weighing errors of omission and commission in decision support for homeland security resource allocation through all-hazards risk assessment <i>Cheesebrough T, Bennett SP</i> <i>Department of Homeland Security, Office of Risk Management and Analysis</i> |
| 1:50 pm T3-F.2 Characterizing mental models of emerging nanotechnologies: a nano sunscreen study <i>Bostrom A, Hudson R, Scharks T, Gillingland R</i> <i>University of Washington</i> | 1:50 pm T3-G.2 Practical issues: perspectives from a state regulator <i>Jones L</i> <i>Texas Commission on Environmental Quality</i> | 1:50 pm T3-H.2 Shipwrecks vs. environment in Greek waters: code red or fuzzy alarm? <i>Ventikos NP, Louzis KA, Koimtzoglou AN</i> <i>National Technical University of Athens</i> | 1:50 pm T3-I.2 Which one of these is not like the others: a simple, structured methodology for assessing all-hazards risk across the homeland security enterprise <i>Bennett SP, Levine ES, Waters JF, Purdie AJ, Kolasky BP</i> <i>Office of Risk Management and Analysis, US Department of Homeland Security</i> |
| 2:10 pm T3-F.3 The effect of labeling nanotechnology products on public risk and benefit perception <i>Siegrist M</i> <i>ETH Zurich, Switzerland</i> | 2:10 pm T3-G.3 Ensuring efficiency in assessment to meet identified needs: the importance of problem formulation/issue identification <i>Meek ME</i> <i>University of Ottawa</i> | 2:10 pm T3-H.3 The role of Cluster Safety Governance (CSG) for preventing cross-plant accidents: developing a game theory based decision aid <i>Pavlova Y, Reniers G</i> <i>Antwerp University</i> | 2:10 pm T3-I.3 Comparing different types of homeland security hazards <i>Keeney RL, Levine ES, Bennett SP, Kolasky RP</i> <i>Duke University, Fuqua School of Business</i> |
| 2:30 pm T3-F.4 Public scholarship for global catastrophic risks <i>Anissimov M</i> <i>Singularity Institute</i> | 2:30 pm T3-G.4 Integrating biomarkers of methyl mercury exposure with determinations of the risk above its RfD <i>Schoeny R</i> <i>US Environmental Protection Agency</i> | 2:30 pm T3-H.4 Transit user risk perceptions after the Washington, DC Metrorail collision <i>Wernstedt K, Murray-Tuite P</i> <i>Virginia Tech</i> | 2:30 pm T3-I.4 The New York City Police Department's efforts to mitigate terrorism risk at private facilities <i>Tisch JS, Falkenrath R, Kelly D</i> <i>New York City Police Department, Counterterrorism Bureau</i> |

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|--|--|--|---|---|
| <p>3:30-5:00 PM 250A</p> <p>T4-A Symposium: Emerging Technologies: Dealing with Uncertainty in Risk Policy <i>Chair: Jennifer Kuzma</i></p> <p>3:30 pm T4-A.1 Dynamic risk governance for converging technologies <i>Kuzma J</i> <i>University of Minnesota, Humphrey Institute of Public Affairs</i></p> <p>3:50 pm T4-A.2 Uncertainty in emerging technologies: influencing assessment, regulation and governance <i>Rocks SA, Alarcon S, Collinson S, Crossley R, Dorey RA, Friedrichs S, Park B, Sutcliffe H, Grayson D, Pollard SJT</i> <i>Cranfield University, UK, Nanotechnology Industries Association, Belgium, NanoKTN, UK, Insight Investment, UK, Responsible Nanoforum, UK</i></p> <p>4:10 pm T4-A.4 Social learning in participatory environmental risk analysis <i>Dana GV, Nelson KC</i> <i>Dana and Sharpe Risk Associates</i></p> <p>4:30 pm T4-A.5 A public health response to contaminants of emerging concern <i>Greene CW, Shubat PJ, Ross M, Dady JM, Goeden HM, Moyer PF, Gust LD</i> <i>Minnesota Department of Health</i></p> | <p>3:30-5:10 PM 250B</p> <p>T4-B Symposium: Current Perspectives on Silver Nanomaterial Risk Assessment and Risk Management <i>Chair: Ron White</i></p> <p>3:30 pm T4-B.1 Environmental implications of nanosilver in the environment <i>Luoma SN</i> <i>University of California, Davis</i></p> <p>3:50 pm T4-B.2 Research priorities for comprehensive environmental assessments of nanomaterials: focus on silver nanoparticles in spray disinfectants <i>Long TC, Ogilvie-Hendren C, Gwinn M, Davis JM</i> <i>US Environmental Protection Agency</i></p> <p>4:10 pm T4-B.3 Identifying information gaps necessary to conduct a comprehensive environmental assessment of nanosilver disinfectant sprays <i>Turley AT, Marenberg AA, McVey ME, Burch DE, Davis JM</i> <i>ICF International, US Environmental Protection Agency</i></p> <p>4:30 pm T4-B.4 The silver nanotechnology working group-the road to registration <i>Volpe R</i> <i>Silver Nanotechnology Working Group</i></p> <p>4:50 pm T4-B.5 Regulatory decisions for nanomaterials - EPA's Office of Pesticide Programs <i>McLain JL, Jordan W</i> <i>US Environmental Protection Agency</i></p> | <p>3:30-5:10 PM 250C</p> <p>T4-C Dimensions of Risk During Extreme Events <i>Chair: Robyn Wilson</i></p> <p>3:30 pm T4-C.1 Perceptions and measurements of weather and climate among the rural poor in Vietnam <i>Cullen AC, Anderson CL, Zelinka M</i> <i>University of Washington</i></p> <p>3:50 pm T4-C.2 Changes in risk perception for hurricane evacuation among Gulf Coast residents, 2006-2008 <i>Trumbo C, Peek L, Marlatt H, Lueck M, Grunfest E, Demuth J, McNoldy B, Schubert W</i> <i>Colorado State University, University of Colorado at Colorado Springs, National Center for Atmospheric Research</i></p> <p>4:10 pm T4-C.3 Pictures may tell it all! Using draw-and-tell methodology to explore visual depictions of hurricane uncertainty <i>Eosco GM</i> <i>University of Kentucky</i></p> <p>4:30 pm T4-C.4 Assessing multiple dimensions of trust among federal fire managers <i>Winter PL, Wilson RA, Toman E, Maguire L, Ascher TJ</i> <i>US Department of Agriculture Forest Service, Pacific Southwest Research Station, The Ohio State University, Duke University</i></p> <p>4:50 pm T4-C.5 Ecological risk perceptions: a Caribbean context <i>Kirby R, Turner MM</i> <i>Center for Risk Communication Research, University of Maryland, College Park</i></p> | <p>3:30-5:10 PM 250D</p> <p>T4-D Symposium: Approaches Used to Understand and Assess Food Safety Issues <i>Chair: David Oryang</i></p> <p>3:30 pm T4-D.1 Risk profile on norovirus: developing an understanding of the transmission pathway as a means of potential control options <i>Fanaselle W, Burkhardt W, Goswami B, Klonz K, Kulka M, Miliotis M, Dennis S</i> <i>Food and Drug Administration-CFSAN</i></p> <p>3:50 pm T4-D.2 Development of information to support risk prioritization using the iRisk Model <i>Jaykus LA, Anderson ME, Muth MK, Beaulieu SM*, Mokhtari A, Bowles E, Newsome R, Paoli G, Dennis SB, Oryang D</i> <i>North Carolina State University, RTI International, Institute of Food Technologists, Risk Sciences International, Food and Drug Administration CFSAN</i></p> <p>4:10 pm T4-D.3 Assessing the risk of preharvest E. coli contamination of produce using climate and environmental data <i>Smith M, Anyamba A, Fanaselle W, Oryang D</i> <i>NASA-GSFC, FDA-CFSAN</i></p> | <p>4:30 pm T4-D.4 Drug residues in milk and milk products risk assessment <i>Fanaselle W, Niles R, McCoig A, Braddy J, Zhou T, Burnsteel C, Obasanjo O, Hooberman B, Luccioli S, Oryang D*</i> <i>Food and Drug Administration</i></p> <p>4:50 pm T4-D.5 Development of a food safety prioritization module for hazard-commodity pairs <i>Mokhtari A, Beaulieu SM, Black P</i> <i>RTI International</i></p> |
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| 3:30-4:30 250F | 3:30-4:30 PM 251A/B | 3:30-5:00 PM 251C/D | 3:30-5:00 PM 251E | 3:30-5:10 251F |
|---|---|--|---|--|
| T4-E Applications of Exposure Modeling <i>Chair: H Ozkaynak</i> | T4-F Risk Perception, Gender and Behavior <i>Chair: Sol Hart</i> | T4-G Future of Risk Assessment <i>Co-Chairs: Julie Fitzpatrick, Rick Reiss</i> | T4-H Crashes, Wrecks, & Emergencies Part 2 <i>Chair: K. Wernstedt</i> | T4-I Symposium: The DHS Integrated Risk Management Framework, Capabilities-Based Planning and Resilience <i>Chair: Bob Kolasky</i> |
| 3:30 pm T4-E.1 Performance evaluation of US EPA's Air Pollutants Exposure Model (APEX): comparison of APEX model predictions to personal exposure measurements <i>Rosenbaum AS, Langstaff JL, Graham S ICF International, US Environmental Protection Agency</i> | 3:30 pm T4-F.2 Attributing responsibility for visitor safety in a national park: an exploratory study <i>Rickard LN, Scherer CW Cornell University</i> | 3:30 pm T4-G.1 The next generation of risk assessment <i>Cote I, Barone S, Dix D, Judson R, Edwards S, Devlin R, Avery J, Preuss P US Environmental Protection Agency</i> | 3:30 pm T4-H.1 Risk attitudes and personality characteristics of emergency physicians <i>Lee RC, Forman S, Culpepper J, Richards M Neptune and Company, Inc., University of New Mexico</i> | 3:30 pm T4-I.1 Words matter: developing a homeland security risk lexicon <i>Gilmour L, Kolasky RP* Department of Homeland Security</i> |
| 3:50 pm T4-E.2 Review of exposure models assessing outdoor use of volatile consumer and industrial products <i>Unice KM, Scott PK, Paustenbach DJ ChemRisk LLC</i> | 3:50 pm T4-F.3 Perceived safety risk and regulatory compliance in the commercial fishing industry <i>Davis ME Tufts University</i> | 3:50 pm T4-G.3 Data fusion application towards a unified dose-response assessment and contaminated sites human health risk analysis <i>Mohapatra AK Health Canada, Alberta</i> | 3:50 pm T4-H.2 Aggregate risk measures and risk aversion <i>MacLean LC, Richman A Dalhousie University, Halifax, Canada</i> | 3:50 pm T4-I.2 A disciplined approach to building risk analysis capability <i>Checknita D DHS - Homeland Infrastructure Threat and Analysis Center</i> |
| 4:10 pm T4-E.3 Apportionment of human exposure to ambient and indoor sources of fine particulate matter <i>Liu X, Frey HC North Carolina State University</i> | 4:10 pm T4-F.4 Understanding climate change issue and gender: a result from group interview on Japanese university students and graduates in Tokyo Metropolitan area <i>Aoyagi-Usui M National Institute for Environmental Studies</i> | 4:10 pm T4-G.4 State cleanup levels for dioxin inform draft interim preliminary remediation goal <i>MacDonell M, Davidson A, Finster M, Scofield M, Peshlov B Argonne National Laboratory</i> | 4:10 pm T4-H.3 Spatial vulnerability assessment using dasymetrics and multi-attribute value functions <i>Kailiponi PK Aston Business School</i> | 4:10 pm T4-I.3 Assessing and conveying risk in a military capability-based framework <i>Bourdon SE, Fong V, Caron JD Defence R&D Canada, Centre for Operational Research and Analysis</i> |
| 4:30 pm T4-E.4 Modeling and evaluation of in-vehicle exposures to fine particulate matter from ambient pollution and smoking <i>Cao Y, Liu X, Frey HC North Carolina State University</i> | | 4:30 pm T4-G.5 The greatest challenge in the risk assessment arena: is the core dilemma productivity vs. sophistication? <i>Wolansky MJ University of Buenos Aires, Argentine National Research Council</i> | 4:30 pm T4-H.4 Decision support for causal analysis in human operator error investigation <i>Yemehyanov AM, Yemehyanov AA Georgia Southwestern State University</i> | 4:30 pm T4-I.4 Can we talk? The limits of TxVxC <i>O'Brien JP Emergency Management & Homeland Security for the County of Clark, Nevada</i> |
| 4:50 pm T4-E.5 A watershed based regional risk assessment and management tool for the South River, VA using Bayesian networks as a component <i>Landis WG, Kolb Ayre K, Markiewicz AJ, Stinson JM Western Washington University</i> | | | | 4:50 pm T4-I.5 Risk culture: towards building a model of analysis and intervention in vulnerable communities. <i>Orozco GA Universidad del Norte</i> |

| 8:30-10:30 AM 250A | 8:30-10:00 AM 250B | 8:30-10:00 AM 250C | 8:30-9:30 AM 250D | 8:30-9:30 AM 250F |
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| W1-A Symposium: TSCA Modernization: Lessons within REACH <i>Chair: Bonnie Gaberek</i> | W1-B Symposium: Mercury Selenium & Millions of Birds at the Great Salt Lake <i>Chair: Christopher Bittner</i> | W1-C Symposium: Risk Communication in the Wild: How Do We Know When We Have Succeeded? <i>Chair: Ian McCammen</i> | W1-D Challenges in Policy Analysis <i>Chair: Lisa Robinson</i> | W1-E Exposure Assessment: Bugs, Drugs, and Metals <i>Chair: Rob Scofield</i> |
| 8:30 am W1-A.1 SIEF management and data sharing under REACH <i>Barrett SM, Penman M, Dederick EJ</i> <i>ICF International, Penman Consulting</i> | 8:30 am W1-B.1 Overview of the ecology and physical habitat of the Great Salt Lake <i>Brown PD</i> <i>Utah Division of Wildlife Resources</i> | Invited roundtable panelists include: Bostrom A; University of Washington Ferson S; Applied Biomathematics Johnson B; Independent Scholar Lofstedt R; King's College London Niederdeppe J; Cornell University Scherer C; Cornell University Wilson R; The Ohio State University | 8:30 am W1-D.1 Economic applications for improving dose-response curves: the case of air pollution <i>Davis ME</i> <i>Tufts University</i> | 8:30 am W1-E.1 A Bayesian Monte Carlo approach to model calibration for weaponized B. anthracis fate and transport <i>Hong T, Gurian PL</i> <i>Drexel University</i> |
| 9:00 am W1-A.2 Adding exposure into the risk equation to subtract out hazard <i>Gaberek BJ</i> <i>E. I. DuPont de Nemours and Company (DuPont)</i> | 9:00 am W1-B.2 Chemical and physical processes that increase the risk of mercury exposure to biota utilizing the Great Salt Lake ecosystem <i>Naftz D, Fuller C, Krabbenhoft D, Perschon C, Luft J, Whitehead J, Gardberg J</i> <i>USGS, UDNR, UDEQ</i> | | 8:50 am W1-D.3 The discount rate for public projects: incorporating heterogeneity in citizen preferences <i>Davis TB, Long MC*, Zerbe RO</i> <i>University of Washington</i> | 8:50 am W1-E.2 An analysis of global regulatory initiatives regarding pharmaceuticals and personal care products; the potential role of bioassays in risk assessment <i>Perez AL, McKinley MA*, Donovan EP, Anderle de Saylor M, Thuett KA</i> <i>ChemRisk</i> |
| 9:30 am W1-A.3 Experiencing REACH exposure assessments <i>Lander DR</i> <i>E.I. DuPont de Nemours and Company</i> | 9:30 am W1-B.3 Mercury in Great Salt Lake biota <i>Gardberg J, Bittner C</i> <i>Utah Division of Water Quality</i> | | 9:10 am W1-D.4 When is a spoon a spoon? The problem with valuing risks and benefits <i>Atapattu A</i> <i>Environmental Risk Management Authority New Zealand</i> | 9:10 am W1-E.3 Exposure and human health risk modeling of mercury emissions as part of EPA's Risk Technology and Review (RTR) program: a case study <i>Burch DF, Turley AT, Shapiro A, McVey MM</i> <i>ICF International</i> |
| 10:00 am W1-A.4 Modernizing TSCA: leveraging lessons learned for assessing chemical safety <i>Becker RA</i> <i>American Chemistry Council</i> | | | | |

Wednesday

8:30-10:00 AM

251A/B

W1-F Poster Platform: Microbial Pathology and

Food Safety

Chair: Abani Pradhan

W1-F.2 Public health impact of listeriosis due to *Listeria monocytogenes* cross-contamination of deli meats at retail level

Pradhan AK, Ivanek R, Gröhn YT, Bukowski R, Wiedmann M

Cornell University, Texas A&M University

W1-F.3 Risk-based approach for microbial food safety in dairy industry. Application to *Listeria monocytogenes* in soft cheese made from pasteurized milk

Tenenhaus-Aziza F, Maffre A, Sanaa M, CNIEL, AFSSA, ACTILAIT*

W1-F.4 A farm transmission model for salmonella for individual EU member states

Hill AA, Simons RRL, Swart A, Kelly L, Hald T, Evers E, Snary EL

Veterinary Laboratories Agency (VLA), National Institute for Public Health and the Environment (RIVM), National Food Institute, Technical University of Denmark

W1-F.5 A transport & lairage model for salmonella in pigs for individual EU member states

Simons RRL, Hill AA, Swart A, Snary EL

Veterinary Laboratories Agency (VLA), National Institute for Public Health and the Environment (RIVM)

W1-F.6 Managing the emerging threat of *Clostridium difficile*

Cragin DW

Merck & Co.

W1-F.7 Proportion and allometric scaling estimates of U.S. food-producing animals versus people: implications on potential antimicrobial resistance risks

Mathers JJ

Alpharma, LLC

8:30-10:00 AM

251C/D

W1-G Symposium Roundtable: The New EPA Regulatory Approach to Drinking Water

Chair: Tee Guidotti

The symposium will feature a balanced panel of four speakers over one and one-half hours, each speaker having 15 minutes for a prepared presentation, followed by a panel discussion and open discussion with the audience for the half hour remaining.

8:30-10:00 AM

251E

W1-H Elicitation, Communication, Participation

Chair: JL Arvai

8:30 am

Facilitation of an organizational risk evaluation process using a novel web-based risk scorecard generator method

Krishen L

Futron Corporation

8:50 am

A community-focused risk analysis tool for evaluating beach contamination: virtual beach-model builder

Mednick A, Parmar R, Wolfe K, Cyterski M, Wong J, Ziegler D, Zepp R, Zdanowicz R, Brody T

Wisconsin Department of Natural Resources, US Environmental Protection Agency, Ozaukee County Public Health Department

9:10 am

Supporting risk management in developing countries: improving decisions by confronting difficult tradeoffs

Kellon DS, Arvai JL

Michigan State University

9:30 am

Informing decision processes using strategic environmental risk assessment

Prpich GP, Pollard SJT, Rocks S, Evans J, Black E, Dagonneau J

Cranfield University

8:30-10:00 AM

251F

W1-I Symposium: Understanding and Managing Public Response to Terrorism and Natural Disasters

Chair: Henry Willis

8:30 am

Dynamics of affect, threat beliefs, perceived risk and intended avoidance behavior during a scenario simulation of an escalating catastrophic biological disaster

John R, Rosoff H

University of Southern California

8:50 am

Modeling the Economy-Wide Consequences of Behavioral Responses to Terrorism Events

*Giesecke R, Burns W, Barrett T, Bayrak E, Rose A**

University of Southern California

9:10 am

Examining Public Response to Natural Disasters and Terrorism: The Role of Systems and Longitudinal Modeling

Burns WJ, Slovic P, Peters E

Decision Research

9:30 am

The Science of Listening: How understanding risk perceptions can lead to better policy

Willis HH

RAND Corporation

| 10:30 AM-Noon 250A | 10:30-11:30 AM 250B | 10:30-11:30 AM 250C | 10:30 AM-Noon 250D | 10:30 AM-Noon 250F |
|--|---|---|--|--|
| W2-A Symposium: Contaminants in Water: Risk Assessment Challenge Ahead <i>Chair: Octavia Cornerly</i> | W2-B Ecological Risk Analysis in Action Part 2 <i>Chair: Kurt Frantzen</i> | W2-C Symposium: Sustainability of Biofuels: Data Needs to Support Environmental & Public Health Perspective <i>Chair: Thomas Biksey</i> | W2-D Biologics and Devices & Public Health <i>Chair: Mark Walderhaug</i> | W2-E Symposium: Infrastructure & Network Risk Analysis <i>Chair: Sarah LaRocca</i> |
| 10:30 am W2-A.1 Addressing risks of drinking water: insights from the NRC Science and Decisions report <i>Zeise L</i> <i>Cal/EPA Office of Environmental Health Hazard Assessment</i> | 10:30 am W2-B.2 Weight of evidence evaluations: a comparative analysis of human and ecological approaches <i>Weinberg NM, Magee B, Bonnerie N, Bartee M</i> <i>Arcadis</i> | 10:30 am W2-C.1 LCA pilot study: water use and wa- ter quality for corn verses cellulosic ethanol <i>Biksey TM</i> <i>WSP Environment & Energy and Uni- versity of Pittsburgh</i> | 10:30 am W2-D.1 Risk assessment of blood donation deferral policies for travel to Mexico and the risk of transfusion-transmit- ted malaria in the United States <i>Yang H, Forshee R, Walderhaug M</i> <i>US Food and Drug Administration</i> | 10:30 am W2-E.1 Rule-based methods for infrastruc- ture risk analysis <i>Reed DA, Zabinsky Z, Boyle LN</i> <i>University of Washington</i> |
| 10:50 am W2-A.2 International developments - more efficiently addressing combined ex- posures to multiple chemicals <i>Meek ME</i> <i>University of Ottawa, Canada</i> | 10:50 am W2-B.3 Evaluating relative risk in environ- mental assessments <i>Ryti RT, Perona R, Bernhard T</i> <i>Neptune and Company, Inc., USAID</i> | 10:50 am W2-C.2 Mycotoxins in ethanol co-products: animal and human health impacts <i>Wu F, Munkvold G</i> <i>University of Pittsburgh, Iowa State Uni- versity</i> | 10:50 am W2-D.2 Effects of shelf-life changes and de- viations from a first-in-first-out pro- tocol on steady-state levels of a stock and flow model of the United States blood supply <i>Walderhaug MO, Simonetti A, Menis M</i> <i>Center for Biologics Evaluation & Re- search, US Food and Drug and Adminis- tration</i> | 10:50 am W2-E.2 Statistical modelling of power outage duration times in the event of hurri- cane landfalls in the US <i>Nataghi R, Guikema SD*, Quiring SM</i> <i>Johns Hopkins University</i> |
| 11:10 am W2-A.3 Possible application of cumulative risk assessment to drinking water regulation <i>Doyle EA</i> <i>US Environmental Protection Agency</i> | 11:10 am W2-B.4 Identifying information-rich charac- terization attributes for nanomaterial toxicity risk assessment <i>Gernand JM, Casman EA</i> <i>Carnegie Mellon University</i> | 11:10 am W2-C.4 Problem formulation for environ- mental risk assessment of feedstock cultivation necessary to meet national biofuel production targets <i>Frederick RJ, Ridley CE, Shaw DM,</i> <i>LeDuc SD</i> <i>US Environmental Protection Agency,</i> <i>Washington, DC</i> | 11:10 am W2-D.3 Estimating the risks and benefits of home-use HIV test kits <i>Forshee RA, Cowan E, Hoffman H</i> <i>US Food and Drug Administration</i> | 11:10 am W2-E.3 Topological bounds for reliability and risk assessment of large lifeline sys- tems <i>Rokneddin K, Dueñas-Osorio L</i> <i>Rice University</i> |
| 11:30 am W2-A.4 QSAR, TTC and their application to a variety of toxicology endpoints for food additives <i>Arvidson KB, Yang C, McCarthy A,</i> <i>Cheeseman M</i> <i>US Food and Drug Administration</i> | | | 11:30 am W2-D.4 A framework for food borne illness risk analysis of frozen not-ready-to- eat microwavable foods <i>Jones DD, Subbiah J, Hanson BW</i> <i>University of Nebraska-Lincoln</i> | 11:30 am W2-E.4 Network topology and vulnerability in infrastructure systems <i>LaRocca S, Guikema S</i> <i>Johns Hopkins University</i> |

| 10:30 AM-Noon 251A/B | 10:30 AM-Noon 251C/D | 10:30 AM-Noon 251E | 10:30 AM-Noon 251F |
|---|---|---|---|
| W2-F Perspectives on Risk Communication and Perception in the Health Industry <i>Chair: Victoria Campbell</i> | W2-G Probabilistic Risk Issues <i>Chair: Dale Hattis</i> | W2-H Mental Models, Psychology and Biology <i>Chair: Thomas Seager</i> | W2-I Symposium: Integrating Quantative and Qualitive Approaches to Achieve Resource and Security Objectives in the US Department of Defense <i>Chair: Renae Dittmer</i> |
| 10:30 am W2-F.1 Communicating risks and benefits about contentious health topics: the case of human induced Pluripotent Stem (iPS) cells <i>Longstaff H, McDonald M, Bailey J</i> <i>The University of British Columbia</i> | 10:30 am W2-G.1 A Bayesian Markov Chain Monte Carlo Simulation procedure for risk assessment by using human data <i>Chen C-C, Wang I-J, Wu K-Y*</i> <i>National Taiwan University</i> | 10:30 am W2-H.1 A Canadian, an American and a Brit were walking down a street - using mental models derived from scenario analysis with a group of experts to change risk taking behaviour <i>Hall IS</i> <i>Lloyds Banking Group</i> | 10:30 am W2-I.1 Emergent conditions and energy assurance for military and industrial installations <i>Karvetski CW, Lambert JH, Dittmer RD, Keisler JM, Linkov I</i> <i>University of Virginia, STRATCON LLC, University of Massachusetts Boston, USACE</i> |
| 10:50 am W2-F.2 Familial risk of cancer - it is the target that makes the arrow probable <i>Eisinger F, Boubnik AD, Malavolti L, Le Coroller Soriano AG, Julian-Reynier C</i> <i>Inserm U-912</i> | 10:50 am W2-G.2 Probabilistic modeling of human exposure and dose in performance assessments of radioactive waste disposal <i>Perona R, Lee R, Tauxe J, Black P, Fitzgerald M</i> <i>Neptune and Company</i> | 10:50 am W2-H.2 Off the top of your head: exploring the influence of mental associations on risk and benefit perceptions of biofuels <i>Cacciatore MA, Brigham Schmuhl N, Binder AR, Scheufele DA, Shaw BR</i> <i>University of Wisconsin-Madison</i> | 10:50 am W2-I.2 Structuring the design space for energy security at military installations - generating portfolio alternatives for understanding the risk of emergent conditions <i>Hamilton M, Lambert J, Dittmer R</i> <i>University of Virginia</i> |
| 11:10 am W2-F.3 Public perceptions of increased post-authorization vigilance towards pharmaceutical sector sustainability <i>Chakraborty S</i> <i>Kings College London</i> | 11:10 am W2-G.3 A whole-body physiologically-based pharmacokinetic model of tocopherol for rats to support its studies as a protective agent against neurotoxins <i>Mukherjee D, Georgopoulos PG, Isukapalli SS</i> <i>Environmental and Occupational Health Sciences Institute, a Joint Institute of UMDNJ RWJ Medical School and Rutgers University</i> | 11:10 am W2-H.3 The influence of spontaneous associations evoked by nuclear power plants on the acceptance of nuclear power <i>Keller C</i> <i>ETH Zurich</i> | 11:10 am W2-I.3 Department of Defense risk analysis and management <i>Trump B, Linkov I</i> <i>Carnegie Mellon University, Army Corps of Engineers</i> |
| 11:30 am W2-F.4 Illness or crime: framing prescription and illicit drug use in online tabloids <i>LaVail KH, Allen-Catellier J*</i> <i>University at Buffalo</i> | 11:30 am W2-G.4 Uncertainty distribution for the Regional Gas Dosimetry Ratio (RGDR)—interspecies projection for water soluble/reactive gases <i>Hattis D, Lynch M</i> <i>Clark University</i> | 11:30 am W2-H.4 The ambiguity of life: how biology and ecology affect risk communication and decision making <i>Siegrist J, Ferson S</i> <i>Applied Biomathematics</i> | 11:30 am W2-I.4 Incorporating the International Risk Governance Council best practices into the Chairman of the Joint Chiefs of Staff risk assessment system <i>Rouse JF</i> <i>Arete Associates, supporting The Joint Staff</i> |

Wednesday

| 1:30-3:00 PM 250A | 1:30-3:00 PM 250B | 1:30-3:00 PM 250C | 1:30-3:10 PM 250D | 1:30-2:30 PM 250F |
|---|--|--|--|--|
| W3-A Symposium: Methodologies for Global Catastrophic Risk Assessment <i>Chair: Seth Baum</i> | W3-B Nano Risk Perception: Views from Experts, the Public and the Media <i>Chair: Katherine McComas</i> | W3-C The Role of Message Framing and Trust in Communicating Health Risk <i>Chair: Delanie Kellon</i> | W3-D Tungsten Compounds Research and Risk Assessment <i>Chair: James Solyist</i> | W3-E Oil Spill Exposures <i>Chair: Rob Scofield</i> |
| 1:30 pm Global catastrophic risk and regula- tory design <i>Ronell A</i> <i>University of Illinois</i> | 1:30 pm Public perceptions of food-based nanotechnology <i>Hallman WK, Cuite CL, Scheufele DA</i> <i>Rutgers, The State University of New Jersey</i> | 1:30 pm H1N1 risk and trust: learning from first nations and metis experiences <i>Driedger SM, Jardine CJ, Furgal C, Cooper EJ, Bartlett J</i> <i>University of Manitoba, University of Alberta, Trent University</i> | 1:30 pm Tungsten compounds research and risk assessment <i>Solyist JM</i> <i>ENVIRON Intenational</i> | 1:30 pm Estimating the airborne concentra- tions of benzene and other relevant volatiles in boats operating in or near oil spills: a comparison between the Exxon-Valdez and Deepwater Hori- zon incidents <i>Avens HJ, Keenan JJ, Unice KM, Paustenbach DJ</i> <i>ChemRisk, CO, CA, PA</i> |
| 1:50 pm Systematic scenario analysis to char- acterize global catastrophic risk <i>Schweizer V</i> <i>National Center for Atmospheric Research</i> | 1:50 pm US newspaper coverage of nanotech- nology risk regulation issues <i>Friedman SM, Egolf BP</i> <i>LehighUniversity</i> | 1:50 pm Responses to vaccination recommen- dations in an experimental field study based on attribute and goal framing within messages <i>Haydarov R, Gordon JG*</i> <i>Kansas State University</i> | 1:50 pm Health effects of embedded frag- ments of tungsten and tungsten al- loys <i>Roszell LE, Houpt A, Beall P, Picut CA</i> <i>Army Institute for Public Health</i> | 1:50 pm Cutting-edge technologies and blunt- instrument responses: early lessons from the blowout of the BP/Deep- water Horror Zone <i>Freundenburg WR, Gramling RB</i> <i>University of California, Santa Barbara</i> |
| 2:10 pm Catastrophic risk forecasts from ref- uge entry futures <i>Hanson RD</i> <i>George Mason University</i> | 2:10 pm Benefits, risks, and regulation of nanomaterials: results from an expert survey <i>Beaudrie CEH, Satterfield T, Kandlikar M, Herr Harthorn B</i> <i>University of British Columbia</i> | 2:10 pm Too scared or too capable? Why do college students stay away from infor- mation about H1N1 flu vaccine <i>Yang ZJ</i> <i>State University of New York at Buffalo</i> | 2:10 pm Corrosion Behavior of Tungsten Heavy Alloys in Rat Muscle Tissue and in a Simulated Physiological So- lution <i>Schuster BE, Demaree JD, Miller CE, Ramirez DA, Murr LE, Roszell LE</i> <i>US Army Research Laboratory</i> | 2:10 pm A model for analysing organisational risk <i>Seno-Alday S</i> <i>The University of Sydney</i> |
| 2:30 pm On assessing the risk of nuclear war <i>Scouras J, Bennett A, Booker J, Toton E</i> <i>Johns Hopkins University, Georgetown University, Booker Associates, Toton Incorporated</i> | 2:30 pm Researcher views about funding sources and conflicts of interest in nanotechnology <i>McComas KA</i> <i>Cornell University</i> | 2:30 pm Using audience tailoring and theo- retically derived messages to improve risk communication initiatives <i>Turner MM, Skubisz C*, Kim J</i> <i>University of Maryland</i> | 2:30 pm Carcinogenicity of embedded tung- sten alloys <i>Kalinich J</i> <i>AFRRI</i> | |
| | | | 2:50 pm Development of a systemic long- term occupational inhalation Derived No Exposure Effect Level (DNEL) for insoluble tungsten substances based on a 28-day inhalation toxicity study on tungsten blue oxide <i>Lemus R, Jackson M, Heim K, Sullivan D, Pardus M</i> <i>ARCADIS INC., IIT Research Institute</i> | W3-E.1 W3-E.2 W3-E.3 |

| 1:30-3:00 PM 251A/B | 1:30-3:00 PM 251C/D | 1:30-3:00 PM 251E | 1:30-2:30 251F |
|---|---|--|---|
| W3-F SARF (Social Amplification of Risk Framework): Applications and Adjustments <i>Chair: Amanda Boyd</i> | W3-G Analysis of Infectious Agents <i>Chair: Peg Coleman</i> | W3-H Public, Animal & Occupational Health <i>Chair: Sophie Rocks</i> | W3-I Food Safety and Sustainability <i>Chair: Louie Rivers</i> |
| 1:30 pm Risky business: an analysis of the Toyota recall <i>Allen Catellier JR, Yang J</i> <i>University at Buffalo</i> | 1:30 pm Bayesian model comparison of dose-response models for biological agents <i>Mitchell-Blackwood J, Gurian P</i> <i>Drexel University</i> | 1:30 pm Assessment of consequences of exotic fish disease incursions in England and Wales <i>Payno Morant M, Prpich G, Peeler E, Thrush M, Rocks SA*, Pollard SJT</i> <i>Cranfield University, UK, Centre for Environment, Fisheries and Aquaculture Science, UK</i> | 1:30 pm Exploring the effects of government-public relationship, anger and communication behaviors on public activism related to mad cow disease risk <i>Han JW, Kim HK</i> <i>Cornell University</i> |
| 1:50 pm Reconsidering risk amplification: content analysis of thematic emphasis in newspaper coverage of a proposed biological research facility <i>Binder AR, Liang X, Brossard D, Schenfele DA, Gunther AC</i> <i>University of Wisconsin-Madison</i> | 1:50 pm Spatial epidemiology as a tool to better understand influenza-like illnesses: lessons for pandemic preparedness <i>Rush-Sirski A, Driedger SM</i> <i>University of Manitoba</i> | 1:50 pm Application of total systems and network analysis in the prevention of exotic animal disease outbreaks <i>Delgado J, Longhurst P, Snary E, Pollard S</i> <i>Cranfield University</i> | 1:50 pm Reviving “think globally, act locally:” the promise of asymmetric paternalism for managing the risks of global change <i>Campbell V, Arvai J</i> <i>Michigan State University</i> |
| 2:10 pm Adapting the social amplification of risk framework for the 21st Century <i>Cummings CL</i> <i>North Carolina State University</i> | 2:10 pm Dose-response model of Rocky Mountain Spotted Fever (RMSF) for human <i>Tamrakar SB, Haas CN</i> <i>Drexel University</i> | 2:10 pm Using QMRA to inform source attribution and public health decision-making in Canada: a focus on cryptosporidiosis <i>Pintar KDM, Fazil A, Pollari F, Waltner-Toews D, Charron D, McEwen S, C-EnterNet Team Members</i> <i>Public Health Agency of Canada, University of Guelph, International Development and Research Council</i> | 2:10 pm Supporting international development decisions: integrating insights from risk communication and decision aiding for household water treatment in East Africa <i>Post K, Arvai J</i> <i>Michigan State University</i> |
| 2:30 pm Ragin’ contagion: viral media and the social amplification of risk <i>Morain MM</i> <i>North Carolina State University</i> | 2:30 pm Animal and human dose-response models for prominent brucella species <i>Teske SS, Huang Y, Bartrand T, Tamrakar S, Haas CN</i> <i>Drexel University</i> | 2:30 pm Using risk analysis to guide control of occupational health hazards <i>Hearl FJ, Pana-Cryan R</i> <i>National Institute for Occupational Safety and Health</i> | |

| 3:30-5:00 PM 250A | 3:30-5:10 PM 250B | 3:30-5:10 PM 250C | 3:30-5:10 PM 250D | 3:30-5:00 PM 250F |
|--|--|--|---|--|
| W4-A Symposium: Climate Change and Global Catastrophic Risk <i>Chair: Vanessa Schweizer</i> | W4-B Symposium: Nothing New About Nano? Making Interdisciplinary Advances in Risk Perception Research <i>Chair: Barbara Herr Hawthorn</i> | W4-C Risk and Engineering Systems <i>Co-Chairs: W McGill, M. Wood</i> | W4-D Symposium: Microbial Risk Assessment Guidelines <i>Chair: Audrey Ichida</i> | W4-E All Routes of Exposure <i>Chair: J Sabmel</i> |
| 3:30 pm W4-A.1 Climate change: a problem of optimal control or risk management? <i>Cooke RM, Kousky C</i> <i>Resources for the Future</i> | 3:30 pm W4-B.1 Not yet a hot topic? Affective ambivalence and nanotechnologies <i>Corner A, Pidgeon N*</i> <i>Cardiff University</i> | 3:30 pm W4-C.1 Utilization of reliability analysis for the back calculation of an explosive load <i>Sorensen AD, McGill WL</i> <i>The Pennsylvania State University</i> | 3:30 pm W4-D.1 Overview of the interagency microbiological risk assessment guideline <i>Dearfield K</i> <i>USDA-FSIS</i> | 3:30 pm W4-E.1 Using advanced dispersion models and mobile monitoring to characterize the contribution of traffic to spatial patterns of ultrafine particles in Brooklyn, NY <i>Zwack LM, Levy JI</i> <i>Harvard School of Public Health</i> |
| 3:50 pm W4-A.2 Space-time discounting, global catastrophic risk, and climate change economics <i>Baum SD</i> <i>Pennsylvania State University</i> | 3:50 pm W4-B.2 Exploring the pre-history of risk perceptions: on the implications of upstream risk perception work for existing evidence and theory <i>Satterfield T, Hawthorn B, Pidgeon N</i> <i>University of British Columbia</i> | 3:50 pm W4-C.2 Safety concerns valuation in biofuels overall processes: new concerns and mitigation risk protocol handling with alternative fuels <i>Lizurazo JJ, Cardenas CA, Muñoz F</i> <i>Andes University</i> | 3:50 pm W4-D.2 Application of the interagency MRA Guideline in food <i>Kause J</i> <i>US Department of Agriculture</i> | 3:50 pm W4-E.2 Assessment of the contribution of dermal pathways to indoor exposure to SVOCs <i>Cousins AC, Shirai JH, Kissel JC*</i> <i>University of Washington</i> |
| 4:10 pm W4-A.4 The tragedy of the uncommons: catastrophe, precaution, perceptions and politics <i>Wiener JB</i> <i>Duke University</i> | 4:10 pm W4-B.3 Public knowledge, recreancy, and nanotechnology: a call for empirical research <i>Freudenburg WR, Collins MB*</i> <i>University of California, Santa Barbara</i> | 4:10 pm W4-C.3 An integrated approach to project risk analysis <i>Cretu O, Cretu V*</i> <i>Cretu LLC</i> | 4:10 pm W4-D.3 Application of the MRA guideline for human spaceflight <i>Ott CM</i> <i>NASA - Johnson Space Center</i> | 4:10 pm W4-E.3 Estimating occupational dermal exposures to benzene <i>Williams PRD, Sabmel J, Knutsen J, Spencer J</i> <i>E Risk Sciences, LLP, ChemRisk, Colorado School of Mines, Environmental Profiles, Inc.</i> |
| 4:30 pm W4-A.5 Rare disasters, risk attitudes, and ambiguity in the economic analysis of climate policy <i>Gerst MD, Howarth RB, Borsuk ME*</i> <i>Dartmouth College</i> | 4:30 pm W4-B.4 In case of emergency, use your attitude: a cognitive-ecological approach to nanotechnology risk perception <i>Palma-Oliveira JM, Carvalho RG, Carvalho J, Soeiro V, Luis S</i> <i>University of Lisbon</i> | 4:30 pm W4-C.4 Risk-based priorities to protect transportation infrastructure corridors from adjacent commercial and residential development <i>Thekedi SA, Lambert JH</i> <i>University of Virginia Center for Risk Management of Engineering Systems</i> | 4:30 pm W4-D.4 Application of the interagency MRA Guideline for water (ambient and drinking) <i>Soller JA</i> <i>Soller Environmental</i> | 4:30 pm W4-E.4 Potential risks of polychlorinated biphenyls in human milk to infants <i>Julius C, Luke N</i> <i>CDM</i> |
| | 4:50 pm W4-B.5 What's new about nano? Nano risk perception specialist meeting January 2010 <i>Hawthorn BH, Pidgeon N, Satterfield T</i> <i>University of California at Santa Barbara, Cardiff University, University of British Columbia</i> | 4:50 pm W4-C.5 An evaluation of denser than air dispersion models <i>García S, Muñoz F</i> <i>Universidad de los Andes</i> | 4:50 pm W4-D.5 Application of the interagency MRA Guideline for airborne exposures <i>Thran B</i> <i>US Army</i> | |

| 3:30-5:00 PM 251A/B | 3:30-5:10 PM 251C/D | 3:30-5:00 PM 251E | 3:30-5:10 PM 251F |
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| W4-F Poster Platform: Risk Assessment of Inhaled Hazards <i>Chair: David Galbraith</i> | W4-G Risk in the World <i>Chair: Rob Schnatter</i> | W4-H Humans, Agents, and Models <i>Chair: Craig Kundrot</i> | W4-I Symposium: Mercury Exposure and Health Effect Reference Values <i>Chair: G. Woodall, M. Engle</i> |
| W4-F.1 Estimated risk of MRSA colonization among swine workers <i>Kocian JL, Shirai JH, Kissel JC, Meschke JS</i> <i>University of Washington</i> | 3:30 pm W4-G.1 Environmentally realistic mixtures of haloacetic acids exhibit concentration-dependent departures from dose additivity <i>Simmons JE, Dingus C, Wagner ED, Teuschler LK, Rice G, Plena MJ</i> <i>NHEERL/ORD/US Environmental Protection Agency, NC, Batelle, OH, University of Illinois, NCEA/ORD/US Environmental Protection Agency, OH</i> | 3:30 pm W4-H.2 An agent-based model for risk-based regulation <i>Davies GJ, Kendall G, Soane E, Li J, Rocks SA, Pollard SJT</i> <i>Cranfield University, School of Applied Sciences, UK, University of Nottingham, School of Computer Science, UK, London School of Economics, Department of Management, UK</i> | 3:30 pm W4-I.1 The UNEP global mercury program and its relevance to reducing mercury inhalation problems <i>Engle M, Durkee S, Bailey M</i> <i>US Environmental Protection Agency</i> |
| W4-F.2 Estimated risk to children of MRSA colonization from intertidal beach sand <i>Levin EA, Kocian JL, Su-Miao L, Roberts MC, Kissel JC, Meschke JS</i> <i>University of Washington</i> | 3:30 pm W4-G.3 Pooled analysis of benzene petroleum workers <i>Schnatter AR, Glass D, Rushton L, Tang G</i> <i>ExxonMobil Biomedical Sciences, Inc., Monash University, Imperial College, University of Pittsburgh</i> | 3:50 pm W4-H.3 Analysis strategy for risk assessment of human health risks portfolio <i>Anton WR, Edwards JM, Kundrot CE, Robotham KO*</i> <i>NASA Human Research Program, Futron Corporation, Wyle Integrated Science and Engineering</i> | 3:45 pm W4-I.2 Comparison of health-based inhalation reference values for addressing exposures to elemental mercury <i>Woodall GM, MacDonell MM, Peshlov BN</i> <i>US Environmental Protection Agency, Argonne National Laboratory</i> |
| W4-F.3 Analysis of different quantitative microbial risk assessment models for legionella infection <i>Willet F, Le Brun M, Charton-Bissetta J, Musson-Genon L, Bickert H, Cabanes PA*</i> <i>Service des Etudes médicales EDF, France, EDF Recherche et Développement, France, Société de Calcul Mathématiques, France</i> | 4:10 pm W4-G.4 A two-stage dose-response adaptive design method for establishing a proof of concept <i>Tanaka Y, Anderson S, Sampson AR</i> <i>University of Pittsburgh</i> | 4:10 pm W4-H.4 Logarithmically scaled risk matrices <i>Levine ES</i> <i>Department of Homeland Security Office of Risk Management and Analysis</i> | 4:00 pm W4-I.3 Mercury mining and use in colonial Andean silver production: emissions and health implications <i>Robins NA, Hagan NA*</i> <i>North Carolina State University, Oak Ridge Institute for Science and Education</i> |
| W4-F.4 Pleural mesothelioma in U.S. auto mechanics: expected vs. reported cases from 1975-2007 <i>Finley BL, Scott LLF, Galbraith DA</i> <i>ChemRisk, LLC</i> | 4:30 pm W4-G.5 Categorizing the types of risks to public health from counterfeit pharmaceuticals <i>Moyer D</i> <i>Michigan State University Program in Public Health</i> | 4:30 pm W4-H.5 What are serious games and what can they do for the risk community? <i>McGill WL</i> <i>College of Information Sciences and Technology, The Pennsylvania State University</i> | 4:20 pm W4-I.4 Characterizing airborne mercury releases from gold shops in South America <i>Fernandez LE, Habegger L, Peterson D, Brass B, Engle M</i> <i>Argonne National Laboratory</i> |
| | | | 4:40 pm W4-I.5 Reducing mercury releases from artisanal gold mining: a low cost mercury emission reduction technology for gold shops <i>Fernandez LE, Habegger L, Bailey J, Engle M, Bailey M</i> <i>Argonne National Laboratory</i> |

SYMPOSIA DESCRIPTIONS

MONDAY

M2-A Analysis and the Policy Process

There are many places in the policymaking process where analysis is given an explicit role. There are also many types of analysis. Examples include risk analysis, cost-benefit analysis, environmental impact analysis, and analysis of information quality. Examinations of the roles that each of these types of analysis plays tends to take place in a vacuum. This is understandable as each type of analysis presents specific challenges. This panel however brings together experts in various types of analysis to attempt to draw lessons that apply to analysis generally. When can expert analysis contribute to policy making? What are the commonly experienced roadblocks to analytical inputs. Most importantly, as we contemplate new analytical requirements, what lessons can be drawn to ensure that any new such requirements lead to better policy outcomes rather than requirements that look good on paper but have few substantive effects.

M2-B/M3-B Decision Support Methods for Nanomaterial Risk Assessment and Risk Management Part 1

This symposium examines recent developments in and uses of collective judgment techniques that could be employed in support of risk assessment and risk management decisions related to engineered nanomaterials. The symposium consists of two sessions of 90 minutes each. Part 1 features presentations of selected methods: BayesNet, Expert Elicitation, Multi-Criteria Decision Analysis, Nominal Group Technique. Part 2 features a prepared commentary by a Discussant on the strengths and weaknesses of different methods, followed by responses from the respective presenters and general discussion involving questions and comments from the audience. This symposium is jointly sponsored by the Emerging Nanoscale Materials and the Decision Analysis and Risk specialty groups.

M2-D Biologically-Based Dose Response Models-Cancer

The recent rapid progress in the understanding of the fundamental biological processes underlying carcinogenesis has led to the hope that dose-response models in cancer risk assessment could be based on biological, rather than purely statistical, considerations. However, recent commentaries on the topic in a high-profile journal have expressed considerable skepticism that biologically-based dose-response (BBDR) models are to be preferred to purely statistical approaches, particularly for the problem of low-dose extrapolation of carcinogenic risk. This symposium will examine the role of BBDR models in cancer risk assessment by bringing together prominent and well-known researchers on both sides of the issue. The role and limitations of BBDR models for analyses of toxicologic and epidemiologic data will be discussed. It is hoped that at the end of the symposium a broad consensus can be reached on the appropriate role for BBDR models in cancer risk assessment.

M2-E Challenges & Opportunities at the Infra-Envi Nexus

This session focuses on, in the words of John D. Schilling, the infrastructure-environment nexus. In this session, several themes emerging in infrastructure systems risk analysis will be addressed, including: emergent properties of large-scale interconnected Earth systems; life-cycle analysis of infrastructure sustainability; environmental impacts of infrastructure innovations; and infrastructure policy learning impacts on public health.

M2-H Plausibility and Risk

In recent catastrophes, from the financial meltdown to the Gulf oil spill, the events occurring came from outside of the risk frameworks being used to make decisions. The probabilities of these events seemed so low that they were not thought sufficiently likely to warrant attention, and it was assumed we had enough experience in the relevant realm that if we did not have a clear indicator of catastrophe, it was not worth worrying about. Yet the improbable occurred. The catastrophes might have been improbable, but they were not implausible. This symposium will take a closer look at plausibility and its relationship to risk. Plausibility arises in studies related to the future,

and is usefully deployed in planning and decision-making. Disciplines from medicine to economics to law draw upon it, yet it is rarely studied directly. It is also a mundane concept, tangible and at the same time embodying intriguing aspects requiring further examination. It is inherently bound by contextual properties: it has cultural, political, social, and emotional dimensions. What is plausible for some is implausible for others. Both plausibility and implausibility need to be interrogated and better understood. What makes something legitimately plausible? And how can plausibility be used to inform risk analysis? Is plausibility a successor to risk, a concept more appropriate for our complex technological world where the unlikely happens, with powerful ramifications? Or is plausibility an important component of risk assessment and management, and thus a tool to be added to the risk analysts' capabilities? Historical perspective on probability and plausibility will be combined with current uses of plausibility in risk contexts, examined both empirically and conceptually. The need for expertise from multiple perspectives in generating and assessing the plausible will be made clear, as will the functionality of plausibility analyses in helping to steer our futures.

M2-I Approaches to Modeling Adaptive Adversaries for Risk Analysis

Adversary acts pose a unique threat to U.S. security because they are caused by human agents and thus, extremely adaptive in nature. Knowledge about the functionality of terrorists, their organizations, and their capabilities is perpetually evolving and difficult to acquire. Any decision model built around adaptive adversaries will have to account for the uncertainty that the terrorist has about the alternatives, as well as the uncertainty of the analyst's assumption relative to the terrorist's preferences. Such a climate creates challenges for the development of countermeasures, specifically related to the effectiveness of deterrence, allocation of resources, and optimal monetary investment. This symposium will present ongoing adaptive adversary modeling research and use the understanding to inform risk management decisions under uncertainty. In the first presentation, Milind Tombe et al. will present work using game theory to address security resource allocation and scheduling problems given the various risk and uncertainties of the adaptive adversary. Next, Vicki Bier and Mavis (Chen) Wang will discuss how to construct a reasonable defender prior distribution over possible terrorist preferences through modeling of the adaptive adversary's observed and unobserved attributes. Building on the insights about adversary behavior, Greg Parnell and Jason Merrick will describe work comparing intelligence adversary analysis

methods on the same problem. Finally, Richard John and Heather Rosoff will speak to recent analyses using a system's modeling approach to capture the dynamics and intricacies of the adaptive adversary and defender interaction over time.

M3-A/M4-A Thirty Years After the Benzene Decision: When will Risk Assessment Benefit Workers?

The 1980 Supreme Court decision requiring OSHA to conduct quantitative risk assessment created a vicious circle that has left 130 million U.S. workers facing some of the largest individual risks that today's assessors will (it is hoped) ever see. SRA members in academia, industry, and government have for decades focused their attention primarily on health and safety risks facing residents and consumers, and have become embroiled in science-policy controversies that exist only because of the need in these areas to extrapolate beyond the limits of toxicological or epidemiological observations, while exposures within the observable ranges remain unaddressed in the workplace. Meanwhile, OSHA and NIOSH have kept an arms-length relationship to risk assessment (and to the Society), citing distaste for the ethical underpinnings of risk assessment and concerns about its reliability and resource demands. This symposium will mark the 30th anniversary of the Benzene decision, and the 40th anniversary of OSHA, with presentations on the science, law, and policy of occupational risk assessment. Speakers will address five major thematic areas: (1) a risk-based agenda of unfinished business, drawing both on burden-of-disease analysis and on insights from a large and recently declassified database of occupational exposures; (2) contrasting perspectives on whether Benzene's mandate to conduct QRA was a setback or an untapped opportunity for OSHA; (3) various ideas to funnel the intellectual energy of SRA into occupational science and policy; (4) proposals for improving federal and state regulatory and non-regulatory capacity to solve occupational risk problems, including accelerated standard-setting, embrace of a HACCP-like model of industry self-regulation, and risk-based technology options analysis; and (5) discussions of possible inter-agency coordination and/or reorganization to solve occupational problems jointly with environmental, agricultural, transportation, and other hazards.

M3-D Salmonella in Low Moisture Foods: Understanding & Quantifying

Several recent large outbreaks of food-borne illness in the US have arisen from Salmonella contamination of low moisture foods, such as pea-

nut butter in 2006-7 and 2008-9, and black and white pepper in 2009. This session will begin with an analysis of food-borne illness from Salmonella contaminated low moisture foods in the U.S over the last sixty years. The session will then address the unique characteristics of Salmonella and low moisture foods that make this pathogen-commodity pair such a threat to public health. Next, critical prevention and control strategies required in the processing and manufacturing environment will be presented. A detailed discussion of variability and uncertainty in pasteurization validation methods will follow. The session will conclude with a discussion of the development of a risk profile for pathogens in spices by the FDA.

M3-E Reconstruction of Exposure & Dose

Choice and Chance: Engaging the Public was an SRA - 2007 Symposium that attracted much interest, participation, ideas, and suggestions for more fully and effectively engaging the general public in risk awareness and decision making. This 2010 session presents progress and current perspectives from a group very involved in and committed to public awareness, education, and engagement. Each panelist will present a short talk related to his/her activities and perspectives. About half of the total session time will be used for audience input, ideas, and dialogue. The goal is to involve and empower the SRA community to become more involved in activities related to general public awareness, education, and decisions related to risk and uncertainty. Specific areas and resources to be covered include: interactive exhibits in museums, schools, etc; personalized, Faces-based, visualization tools and approaches; use of humor, cartoons, and caricatures; games and simulations; narrative, story, and related affective approaches. The participants represent risk analysis professionals (Slovic and Thompson), psychologists (Drews and Slovic), and informal education professionals (Andrade and Anter).

M3-I Modeling Developmental Toxicity Data

Prenatal developmental toxicity studies are designed to provide general information concerning the effects on the developing organism following exposure of the pregnant test animal to a chemical substance. Effects commonly investigated include death, structural and visceral malformations, and altered or retarded fetal growth. Although developmental toxicity studies are designed to only include specific periods during gestation, developmental endpoints are considered to be an integral concern in the assessment of potential health effects from continuous lifetime exposures. Accordingly, these data have been used as the basis for the derivation of chronic human health

toxicity values. In order to accurately describe exposure to the developing organism, physiologically-based pharmacokinetic (PBPK) modeling can be used to estimate internal fetal dose metrics. Additionally, the U.S. Environmental Protection Agency (EPA) has developed dose-response modeling methodologies, represented by the application of the nested dichotomous models within EPA's Benchmark Dose software (BMDS), which address specific statistical considerations necessary for the appropriate analysis of developmental toxicity data. Occasionally, however, a lack of information precludes the use of the nested dichotomous models, and alternative modeling strategies are needed. The objective of this symposium is to discuss the use of PBPK models and EPA BMDS methods for the analysis of developmental toxicity data as well as potential alternative modeling approaches, including a statistical approach to account for lack of individual animal data and use of other developmental biology models independent of BMDS. The symposium is comprised of four presentations. Disclaimer: The views expressed in the proposal are those of the authors and do not necessarily reflect the views or policies of the U.S. Environmental Protection Agency.

M4-D Advances in Estimation of Risk from Foodborne Illness

Over the past 10 years, risk analysis has come to play an increasingly prominent role in food safety policy around the world. In the U.S. it is playing a central role in current efforts to strengthen the U.S. food safety system including the President's plan for strengthening food safety, legislation pending before Congress to reform FDA, efforts at USDA and FDA to more effectively focus food safety inspection efforts, and development of public-health based performance standards for USDA and FDA. The President's Food Safety Working Groupd explicitly acknowledged that these efforts rely on the availability of timely data and analysis on the distribution and severity of risks in the food supply. This session presents recent advances in research from epidemiology, risk assessment and economics on provision of the information needed for risk-based food safety policy. The first two papers address the challenge of identifying which pathogens and which foods are causing illnesses. This is a core analytical problem for food safety because these relationships are often not directly observable. Cole and coauthors present new methodological research attributing foodborne illness to food consumption. Ayers and coauthors focus on methods of estimating the pathogen source of foodborne illnesses. Risk management also needs information on the severity and social burden of risks. Hoffmann and coauthors present comprehensive estimates of the cost-of-illness and QALY scores

for 11 leading causes of foodborne illness in the U.S. by both pathogen and food. Scharff and his coauthor present research looking at regional variability in value of statistical life estimates and their implication for assessment of the social burden of foodborne illness. The session will conclude with a panel discussion exploring the potential contributions of research like that presented to design of risk-based food safety policy.

M4-E Risk Analysis of System Interdependences

In his seminal book on Systems Approach, Churchman [1968] defined system as “a set of parts coordinated to accomplish a set of goals.” The same definition still holds true today. With the advent of modern technologies and desire for enhancing business productivity, system interdependencies have significantly grown in size, complexity, and geographic scope. This session will feature four research papers to discuss and underscore the ever-increasing role of risk analysis in assessing and managing system interdependencies.

M4-G Evaluating PBPK Models for Use in Risk Assessment

Publication of a physiologically-based pharmacokinetic (PBPK) model in a peer-review journal generally indicates scientific quality consistent with accepted norms of practice in this discipline. However, in-depth evaluations of published models and their supporting computer code have revealed issues and errors that make them unsuitable for use in risk assessment. The quality of human health risk assessments must be sustained, including use of appropriate PBPK models and other quantitative tools for dose-response evaluation and interspecies extrapolation. While it may be technically possible to modify published models to address assessment-specific issues, the available time and resources can limit the extent of such work. Agencies also seek an appropriate degree of consistency between approaches and standards of science quality applied across multiple assessments. Therefore, clear criteria for the scientific and technical quality of a PBPK model and its computational implementation (code) are desirable, along with a thorough but efficient process for the review and implementation of PBPK models. This symposium convenes experts in risk assessment, biologically-based modeling and relevant quantitative methods to describe and discuss model evaluation and criteria, issues and choices that arise in model application, and methods of assuring reasonable certainty. First, reasons why PBPK model use has previously been limited and potential solutions will be presented, followed by an example process and set of criteria created specifically for eval-

uating PBPK (and other biologically-based) models and bringing them to application. The importance of the source data used to calibrate model parameters will then be described, followed by application-specific approaches for the evaluation of model confidence. Finally, the appropriate choice of parameter distributions to appropriately characterize population variability in probabilistic population models will be discussed.

M4-H Value of Information: What Has Been Done?

Value of Information (VoI) is a concept that applies the valuation of acquiring additional information for informing decisions. Even though this concept is well known in decision analysis, applications of VoI are still rare and primarily focused on decisions with one dimension (monetary measure). Nevertheless, the need to acquire additional information to make decision with scarce available data and limited resources (not just financial, but also personnel and time) opens an immense need for VoI analysis in multiple application areas, including emerging materials (i.e., nanomaterials), chem/bio defense, strategic planning, resource allocation and many others. This session will start with a state of application summary supported by a detailed literature review of VoI case applications published over the last 20 years. It will continue with examples of VoI applications in two decision contexts: manufacturing of nanomaterials and environmental management. It will include a presentation on relating VoI methodology used in single and multi-criteria problems with portfolio methods and tools and conclude with discussion on how to facilitate improved application and acceptance of VoI as a robust risk management tool.

TUESDAY

T2-A Health Impact Assessment, a Powerful Tool for Policy Matters, Who Needs It? How Should It be Used?

Health Impact Assessment (HIA) is process that aims to inform policy decisions across many sectors to promote conditions that support population health. Much broader than traditional health risk assessment, HIA employs a variety of quantitative and qualitative data gathering and analytic methods to identify the potential cumulative health effects—and the distribution of those effects within the population—of a policy, program, project. Initially developed in Europe and Australia, HIA has now been practiced in the US for several years through a number of policy-analytic and regulatory processes at the state and municipal level. This symposium would present the state of the art and practice of HIA in the US today and consider

the potential for expanding its applications. The speakers will address its commonalities with and differences from environmental health risk assessment, regulatory impact assessment, and distributive analyses such as those addressing concerns of environmental justice. The participants represent diverse perspectives and expertise. Collectively, they have conducted environmental health risk assessments, HIAs, economic analyses of the health status and mortality impacts of policy reforms in health care, the social determinants of health, and health risk regulation, and have led collaborative efforts to address population health risks.

T2-B Food Applications of Engineered Nanomaterials Part 1

The research literature indicates that novel engineered nanomaterials (ENM) in food-related applications promise significant food safety, quality and health-promoting benefits in the near future. However, any material added to or used in contact with food must have appropriate regulatory status, and its safety for the intended use must be affirmed. Understanding how novel properties of ENM affect oral toxicity and risk, and addressing key uncertainties in product safety evaluations, are therefore imperative in order for beneficial applications of the technology to reach the market. This session will critically evaluate the available information concerning oral toxicity of ENM relating to food applications and explore current knowledge gaps and uncertainties in hazard characterization, exposure assessment and risk characterization. (Note - a companion session, Part 2 (T3-B) takes place from 1:30-3:00 pm.)

T2-F Communicating Evidence for Risk Characterization

Summarizing and integrating evidence from different research fields, such as epidemiology or animal studies, into an overall evaluation regarding the hazard potential of an agent is a demanding task. A particular problem arises when the evidence consists of a multitude of inconsistent or even contradictory results from scientific studies. This is a situation not unfamiliar to risk assessment experts, but it can be confusing for non experts. It is certainly not surprising that learning about conflicting evidence regarding a potential adverse health effect irritates the public. There are four problem areas that deserve attention when addressing the question of how to deal with conflicting evidence in risk characterization: (I) How does the scientific analysis of risk inform policy making about potential hazards or risks? (II) How is evidence characterized within different research areas? (III) How can evidence from different research areas be integrated into an overall risk

characterization? (IV) How do lay people understand the uncertainties in risk assessment and how can these be communicated to the public? And are there any ethical guidelines that can help in making risk related decisions under uncertainty? The symposium is organized along these questions and presents a new model for communicating conflicting evidence, the evidence map. Evidence maps are designed to depict the reasons which lead experts to their conclusions when summarizing and evaluating the scientific evidence about a (potential) hazard. They provide a graphical representation of the arguments that speak for or against the existence of a causal relationship between exposure to a (potentially) hazardous substance or condition and the endpoints that are considered, as well as the conclusions that are drawn and the remaining uncertainties. Furthermore, data from experimental studies are presented which evaluate the advantages of evidence maps compared with traditional narrative reviews.

T2-H Emerging Contaminants: Implementing Solutions

Department of Defense (DoD) Emerging Contaminants (ECs) are defined as those substances with no existing peer-reviewed toxicity values or health standards or the existing standards are being re-evaluated due to new science. The DoD's three-tiered process to proactively evaluate and mitigate potential impacts from EC comprises conducting impact assessments in five functional areas and the development of risk management options. This symposium will address three ECs of interest to DoD that are also of interest to non-military communities: The presentations reflect how current national and international trends related to risk assessment, analytical procedures, and overall chemical management influence potential impacts to the DoD from these ECs. The symposium opens with an update on DoD's process for identifying, assessing, and managing ECs. Subsequent briefings will focus on three emerging contaminants of specific interest to DoD: lead-free electronics, sulfur hexafluoride, and nanomaterials. First, the symposium discusses the dilemma presented by the transition to lead-free electronics. Despite exclusions for military equipment and solder in high-performance electrical systems, the DoD may be impacted by the transition to lead-free equipment because the DoD's electronic equipment is procured from the same suppliers who comply with international lead-free directives. Second, the symposium addresses how potential restrictions on greenhouse gases could impact unique DoD applications of sulfur hexafluoride. The military's major unique uses of sulfur hexafluoride are for weapon system propul-

sion and waveguide pressurization for aircraft and shipboard radar while the DoD's other uses are similar to those in the commercial sector. Third, the symposium examines the risk-risk tradeoffs associated with development and use of nanomaterials. While the promise of these novel materials has invigorated the scientific community, it is imperative that the potential risks to human health and the environment be identified, assessed and controlled.

T2-I Innovations in Benefit Cost Analysis

Benefit-cost analysis plays an important role in risk management decisions, providing information on the extent to which alternative policy options are likely to lead to benefits in excess of their costs. Such analysis has been required for economically-significant environmental, health, and safety regulations in the US for over 30 years, and is increasingly required by other countries around the world. Our now-extensive experience with conducting these analyses, combined with the substantial expansion of available research, provides many opportunities for innovation and improvement. Such enhancements have been encouraged by the Obama Administration's request for comments on Executive Order 12866, "Regulatory Planning and Review," and by discussions in its recent policy documents. In addition, the John D. and Catherine T. MacArthur Foundation has funded a project to develop Principles and Standards for benefit-cost analyses, through the Center for Benefit-Cost Analysis at the University of Washington. This symposium brings together some of the participants in the MacArthur Foundation effort to discuss the implications of their work to-date for the analysis of risk management programs and policies.

T3-B Food Applications of Engineered Nanomaterials Part 2

The use of novel engineered nanomaterials (ENM) in food-related applications offers potential for significant food safety, quality and health-promoting benefits. Despite these potential benefits, few applications of ENM in food are on the market. Characterization of the risks from ingestion of ENM in food is complicated by a relatively small database of research on exposure to ENM via ingestion. Although few studies explicitly address ENM in food, it may be possible to use research on other ingested ENMs or naturally occurring nanoscale entities in food to guide the risk characterization of ENM in food. Research on orally delivered pharmaceuticals, the microbial flora of the gut, and naturally occurring nanoscale components of food could aid our understanding of the behavior of ingested nanoscale entities in the digestive system. Understanding how novel properties of ENM af-

fect oral toxicity and risk, and addressing key uncertainties in product safety evaluations, are imperative in order for beneficial applications of the technology to reach the market. Building on Session #1, this session will examine approaches to dealing with uncertainties associated with nanoscale properties of ENM, and the status of decision-analytic frameworks for safety evaluation of ENM in food-related products. A panel discussion will bring together the speakers from this session and from session 1 (T2-B).

T3-G Beyond Science and Decisions

This symposium builds on recent 2007 and 2009 National Academies of Science (NAS) publications, specifically the 2009 NAS report, *Science and Decisions: Advancing Risk Assessment*, and addresses approaches to move the science of dose-response assessment forward. The symposium will present findings and discuss progress from the first and second of three workshops. The workshops were organized with a multi-stakeholder approach to share information, ideas, and techniques in support of developing practical problem-driven risk assessment guidance. The first workshop, held in March, 2010, included invited presentations on dose-response assessment techniques, perspectives on the NAS report from several different sectors, and selection of case study proposals to illustrate methods at the second workshop. The remaining workshops are scheduled for October 2010 and April 2011. A science panel will be selected by the Alliance for Risk Assessment (ARA) Steering Committee. Case proposal presentations will be evaluated by the science panel at the second and third workshops. The panel will build consensus on purpose-specific dose-response methods. One aim of these workshops is to develop practical guidance for use of risk assessment techniques applicable to specific issue identification (e.g., prioritization, screening and full assessment) and use by risk managers at a variety of levels (e.g., states, regional managers, people in a variety of agencies, and in the private sector). The first talk highlights the importance of problem formulation in setting the stage for the assessment. The second talk addresses the issue of thresholds, and the third presents a case study of the calculation of risk for a noncancer endpoint. The session concludes with a talk regarding practical issues and implications of the risk values developed from different dose-response techniques.

T3-I All-Hazards Risk Analysis and Other Recent Advances in Homeland Security Risk Management

Over the past year, much progress has been made in risk management at all levels of the Homeland Security Enterprise. The first strategic all-hazards assessment at the Department of Homeland Security was completed, and a new methodology for an all-hazards assessment incorporating value-focused thinking was designed. State and local officials have also begun to incorporate risk into their decision-making, exemplified by the New York City Police Department's Counterterrorism Division. This symposium will include presentations describing these developments, as well as more theoretical discussions regarding the appropriateness of, and possible approaches for all-hazards risk assessments that span terrorism, natural hazards, transnational crime, and other important homeland security domains.

T4-A Emerging Technologies: Dealing with Uncertainty in Risk Policy

Emerging technologies, such as nanotechnology, genetic engineering, and synthetic biology, pose unique portfolios of risk policy issues. There is a high degree of uncertainty associated with risks stemming from their use and the dissemination of their products in health, agricultural, environmental, manufacturing, and consumer product sectors. Hazards are not well-characterized, exposure levels are often unknown or involve replicating organisms, and few concerted efforts to collect risk-relevant data have materialized. Yet, the risks must be assessed, managed, and communicated. Furthermore, the ethical, social, legal, and regulatory issues are more pronounced in the view of diverse stakeholders and citizens with multiple perspectives and concerns. This symposium is designed to bring the issues of risk policy - broadly defined as the policies, approaches, and programs which underlie risk assessment, management, perception, communication, and mitigation—to light and examine them in scholarly and multi-disciplinary ways. Speakers will focus on emerging contaminants, such as nanoparticles and biomolecules, and genetically engineered organisms, as well as products resulting from the convergence of the emerging technologies. Methodologies presented will include expert elicitation, stakeholder dialogues, semi-structured interviews, state-level advisory groups, and international weight-of-evidence approaches, all designed to deal with uncertainty. Quantitative and qualitative data will be presented, along with in-depth ethical analyses. Presenters come from a state agency, a private consulting group, two universities within the U.S., and one university in the UK and represent diverse disciplines such as policy

studies, chemistry, science and technology studies, conservation biology, and philosophy. The symposium should be of broad interest to SRA through its examination of multi-disciplinary and multi-sector methods and approaches for dealing with uncertainty in risk governance for complex technological products and contaminants.

T4-B Current Perspectives on Silver Nanomaterial Risk Assessment and Risk Management

With the commercial availability of several hundred consumer and industrial products that incorporate nanosilver materials, nanosilver currently represents one of the largest potential sources of public exposure to nanomaterials. Recent proposals regarding the regulation of nanosilver pesticide products under the Federal Insecticide, Fungicide and Rodenticide Act, as well as approaches to assessing the risks associated with nanosilver materials, have focused substantial attention and interest in this issue. This symposium will discuss the potential health and environmental impacts of nanosilver exposures, as well as potential benefits, with an emphasis on recent approaches to assessing and managing the risks of nanosilver materials in consumer and commercial products. Speakers will include representatives of federal agencies, academia, as well as the silver nanotechnology industry.

T4-D Approaches Used to Understand and Assess Food Safety Issues

Over recent years, foodborne illness outbreaks and food contamination have frequently grabbed news headlines, and hazards associated with food and food preparation are receiving increasing public, industry and federal government attention. Our understanding and characterization of the sources and pathways of contamination, and the likelihoods of pathogen growth, spread, and survival is limited and has need for improvement. Risk assessment and risk models offer varied approaches and methodologies to assess public health risks posed by some of these food safety problems, and to answer risk management questions. This symposium demonstrates a variety of approaches being developed by FDA-CFSAN and partners to assess and prioritize public health risks posed by food safety problems, and inform risk management. Some of the methods presented include Geospatial Modeling, Risk Ranking, Comparative Risk Assessment, and Risk Profile.

T4-I The DHS Integrated Risk Management Framework, Capabilities-Based Planning and Resilience

The Department of Homeland Security has undertaken a concerted and systematic process for building an integrated risk management framework based on the foundation of doctrine and policy, training, processes, governance, and accountability. This symposium will highlight different efforts and perspectives within that integrated risk management framework from within DHS, the infrastructure protection community, and the State and local perspective, as well as how it is being used to homeland security decision-making. In doing so, it will cover the intellectual underpinnings of the framework with a focus on total risk management as a *modus Vivendi* for homeland security professionals, as well as the process for developing a common Risk Lexicon to support and institutionalize the framework. As a specific example of the benefits to a disciplined approach to integrated risk management, the Homeland Infrastructure Threat and Risk Analysis Center will present their process and implementation of capability based planning and assessment specific to risk analysis. Finally, an official from Clark County, NV will talk about the limits of the Threat x Vulnerability x Consequences (TxVxC) approach to homeland security risk analysis and why it is appropriate for DHS to build a risk management framework that is not based on TxVxC.

WEDNESDAY

W1-A TSCA Modernization: Lessons within REACH

With industry having experienced its first full year of registration preparation and submittal under the European Union's (EU) Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) regulation, an opportunity arises to leverage lessons learned for possible application to Toxic Substances Control Act (TSCA) modernization and implementation. REACH mandates that all chemicals either manufactured within or imported into the EU be registered by industry prior to marketing. Before obtaining permission to market a substance, companies must comply with a number of requirements not previously necessary for chemical management in other jurisdictions of the world. REACH obliges all registrants to formally share hazard information for a chemical in a body called a Substance Information Exchange Forum (SIEF). In addition, REACH necessitates the melding of hazard information with exposure information to quantify or at least qualify in a risk assessment the potential impacts of marketing the chemi-

cal in the EU. The regulation, however, recognizes that both hazard and exposure must be present for adverse impacts to manifest in human health and/or in the environment. Options are offered by REACH where industry may reduce its hazard testing requisites with use of exposure information, a process known as exposure-based adaptation (EBA). The first three presenters in this session will relay their experiences relative to the following topics: 1) SIEF administration and management, 2) exposure assessment roles, focusing primarily on EBA, and 3) REACH quantitative exposure assessment implementation. The last speaker will address the current status of TSCA modernization and offer pragmatic suggestions for integrating lessons learned from REACH into chemical management implementation in the United States.

W1-B Mercury Selenium & Millions of Birds at the Great Salt Lake

Great Salt Lake, Utah (GSL) is a terminal lake with salinity ranging from fresh water to almost 10 times higher than seawater. GSL is valued for its mineral resources, brine shrimp, and wildlife habitat. Management of GSL is challenging because of the diversity of lake users, the sometimes conflicting goals of these users, and multiple regulatory jurisdictions. GSL is part of the Western Hemisphere Shorebird Reserve Network because it supports between 2 to 5 million birds. Salinity, and the ecology, varies in GSL temporally and spatially because of climatic factors such as inflow to the lake and evaporation and anthropogenic factors such as hydraulic modifications. Like all terminal lakes, GSL can be a sink for contaminants. GSL has the highest concentrations of methyl mercury measured in the United States. Mercury has been measured in the biota at GSL at levels that adverse effects are observed at other locations. Currently, selenium is the only substance with a numeric water quality criterion for GSL. This symposium will focus on the efforts to measure and assess the ecosystem, mercury, and selenium at GSL.

W1-C Risk Communication in the Wild: How Do We Know When We Have Succeeded?

The field of risk communication has evolved to include many principles and practical guidelines for crafting messages, understanding audiences, and structuring risk dialogue. For those who communicate risk, these principles and guidelines form a valuable toolbox for designing and implementing programs, campaigns, and interventions across a range of settings. There is, however, one underdeveloped section in our toolbox: practical guidance for defining and evaluating success in real-world risk communications.

This roundtable brings together an interdisciplinary panel of risk communication veterans for an open forum on success in risk communication. Topics to be explored include: defining communication success in context, methods for measuring success, history of evaluation in the field, and the role of successful risk communication in public policy. Following brief presentations by the invited panelists, we'll open the floor for a general discussion of success in risk communication and its role for the future.

W1-G Symposium Roundtable: The New EPA Regulatory Approach to Drinking Water

On 22 March 2010, Lisa Jackson, Administrator of the USEPA, announced a new, nonexclusive framework for drinking water regulation, emphasizing regulation by broad class and proactive risk anticipation, creating an alternative to the contaminant-by-contaminant approach that is both slower and reactive to emerging contaminants. This new approach will introduce a new policy initiative in risk management in the United States and will have practical consequences for implementation, management, and compliance in the community of water utilities and local distribution systems, which are currently under financial and political pressure. Even so, the proposed approach is much different from the regulatory regime of the European Union, which is widely considered to have had notable success in reducing chemical contaminant levels in surface waters. This symposium will address the implications of the new framework with respect to comparative regulatory policy and models, health risk assessment, contaminant monitoring, water quality management, risk communication, and risk management at the level of local government.

W1-I Understanding and Managing Public Response to Terrorism and Natural Disasters

The consequences of a terrorist attack will depend significantly on how citizens respond following the event. Similarly, the effectiveness of emergency preparedness measures will rest on the extent to which citizens follow government recommendations. Decades of risk perception research teaches us that how people react will be influenced by how they perceive the risks they are exposed to. This symposium presents on-going research at the DHS Center for Risk and Economic Analysis of Terrorist Events to improve our understanding of how people react to terrorism and natural disasters and use this stronger understanding to improve public policy. In the first presentation, Richard John (University of Southern California) will describe results

of studies of factors that affect individuals' perceptions of terrorism events. Next, Adam Rose (University of Southern California) will present analysis using CGE models to estimate the indirect economic effects of terrorist events that demonstrates the consequences that result when risk perceptions affect behavior. Building on the insights from these studies, William Burns (Decision Research) will present recent analysis using a systems modeling approach to estimate the public response to disasters and terrorist events. Finally, Henry Willis (RAND Corporation) will describe on-going studies that translate these types of risk and economic analysis studies into recommendations for improving the implementation of homeland security policies.

W2-A Contaminants in Water: Risk Assessment Challenge Ahead

The US Environmental Protection Agency's (EPA) Administrator recently outlined the Agency's new approach to expand public health protection for drinking water by going beyond the traditional framework that addresses contaminants one at a time. The Agency is initiating a national conversation to identify better ways to address contaminants in groups, improve drinking water technology, and more effectively address potential risks to give Americans greater confidence in the quality of their drinking water. EPA will focus on four principles that will provide greater protection of drinking water. The four principles are: 1) address contaminants as groups rather than one at a time so that enhancement of drinking water protection can be achieved cost-effectively, 2) foster development of new drinking water technologies to address health risks posed by a broad array of contaminants, 3) use the authority of multiple statutes to help protect drinking water and, 4) partner with states to share more complete data from monitoring at public water systems. The current approach to drinking water protection is focused on a detailed assessment of each individual contaminant of concern and can take many years. This approach not only results in slow progress in addressing unregulated contaminants but also fails to take advantage of strategies for enhancing health protection cost-effectively, including advanced treatment technologies that address several contaminants at once. The outlined vision seeks to use existing authorities to achieve greater protection more quickly and cost-effectively. Presentations and a panel discussion will highlight how EPA and other Agencies (state, federal and international) have developed various approaches for grouping and ways to effectively address potential risks to strengthen public health protection from contaminants in drinking water.

W2-C Sustainability of Biofuels: Data Needs to Support Environmental & Public Health Perspective

This symposium, in keeping with the SRA 2010 theme “Risk Analysis in Action,” addresses the EPA strategy to increase the supply of renewable fuels, as mandated by the Energy Independence and Security Act (EISA) of 2007, to approximately 36 billion gallons of fuel from renewable sources by 2022. The EPA strategy notes that increasing renewable fuel usage will reduce dependence on foreign oil. However, the sustainability of this strategy is dependent on the public health and environmental consequences, and not just production and cost-effectiveness of alternatives to foreign oil. Our four presenters will speak on topics that address the data and assessment needs from feedstock production through biofuel production to identify how environmental and public health information is dependent on federal research efforts on production and cost-effectiveness, and how this information should be a feedback loop to considering biofuel systems designs. One presentation will focus on problem formulation of feedstock cultivation within an environmental risk assessment framework and meeting the feedstock production goals. The focus on environmental sustainability during conversion of biomass to ethanol is the second presentation that will address water consumption, greenhouse gas, criteria air pollutants, and fossil energy input. A third presentation will evaluate water quality and water consumption needs from feedstock production through bioproduction; this presentation is a pilot study to develop the technical approach for indicators and metrics for an expanded life cycle assessment that includes both public health and the environment. The last presentation will address impacts of by-products and co-products generated in biofuels production; these co-products in livestock and poultry diets can cause adverse health effects to animals. The results of these studies will be used to formulate recommendations that can inform public policy regarding the implementation of EISA.

W2-E Infrastructure & Network Risk Analysis

This symposium focuses on current research in the field of risk analysis for infrastructure systems. The work presented in this session utilizes a range of methodologies, including optimization, statistics, and network theory, to address the problem of vulnerabilities in a variety of systems such as electric power transmission and water distribution. The research discussed here aims to improve the management of risk in infrastructure systems both before and after the occurrence of failures.

W2-I Integrating Quantative and Qualitive Approaches to Achieve Resource and Security Objectives in the US Department of Defense

The United States Department of Defense typically approaches energy and water resource optimization by conducting resource use audits and then employing a cost-benefit analysis of new technologies or capital investments to improve energy conservation measures on a piecemeal, building systems basis. While important gains are often realizable through this traditional approach, to date piecemeal measures have not been sufficient to realize DoD energy objectives. More importantly, traditional analysis does not take into account the potential impacts of modification of various resource optimization strategies and technologies on installation energy and water security. A more holistic approach which leverages community-level analysis and which considers installation mission requirements – especially installation energy and water security – as well as stakeholder priorities and preferences is urgently required. To date, however, typical analytic tools are insufficient for such a holistic investigation. As a result, significant opportunities for additional improvements in resource use without compromising installation missions or energy and water security are masked by the methodology. Evident is that creating ultra-low energy community systems while assuring installation energy security requires a broader, more innovative, integrated quantitative and qualitative approach. In this session we will present findings to date on how two novel approaches – second law analysis of energy quality and multi-criteria decision analysis – are currently being used to generate community-level energy and water savings while assuring that installation energy security objectives can be obtained – both without compromising installation mission.

W3-A Methodologies for Global Catastrophic Risk Assessment

Global catastrophic risks (GCRs) are risks of events that could significantly harm or even destroy civilization at the global scale. GCRs are thus risks of the highest magnitude, regardless of probability. Some GCRs include pandemics, global warfare, ecological collapse, and disruptive emerging technologies. The high stakes and generally unprecedented nature of GCRs pose strong analytical challenges. This symposium features diverse methodological perspectives on how to effectively assess GCRs. Scholars from economics, law, policy, and security analysis present specific methodologies including refuge futures, regulatory design, scenario analysis, and de-

terrence assessment approaches. These methods are examined in terms of how effective it is across different GCRs and what general challenges are posed by the nature of GCR. These insights provide important guidance on how to proceed with ongoing GCR assessment initiatives.

W4-A Climate Change and Global Catastrophic Risk

Global catastrophic risks (GCRs) are risks of events that could significantly harm or even destroy civilization at the global scale. GCRs are thus risks of the highest magnitude, regardless of probability. Climate change has emerged as a particularly important GCR, both for its severity and for the methodological insights found from the study of it. This symposium features diverse perspectives on climate change and GCR. Scholars from economics, geography, law, and mathematics present several important issues in climate change and GCR including the value of statistical life, space-time discounting, political economy, and risk management. These insights from these presentations provide important guidance on how to proceed with ongoing initiatives on climate change and GCR.

W4-B Nothing New About Nano? Making Interdisciplinary Advances in Risk Perception Research

In spite of a growing consumer product inventory, accelerating regulatory action in the US and abroad, and ongoing (though limited) media attention, the US public continues to demonstrate low familiarity and benefit centrism about nanotechnology, although a very large minority of surveyed people across US, Canada, Europe and Japan 2002-2009 indicates they are “not sure” about the risks v. benefits. More recent work presented here explores the specificity of public and expert risk judgments to application (e.g., nanotechnologies for food or energy or medicine), to specific nanomaterials (e.g., TiO₂, CeO), to other social and political contextual variables (ideological, cultural, environmental and other attitudes), and to aspects of life experience and affective response. This session presents an overview of research in the field, results from new, interdisciplinary research from the fields of cultural and medical anthropology, sociology, environmental studies, risk studies, and social psychology and beyond regarding the upstream context for nanotech risk perception research, expert perceptions about risk and regulation, environmental risk perception, and implications for future research on Freudenburg’s recreancy theory. The work is contextualized by a report on an international, interdisciplinary meeting of risk perception specialists in Santa Barbara in January 2010 to discuss the state of the field for nano-

technology, mental models or templates research and public perceptions, relevance of the social amplification of risk framework, public participation, and challenges in the regulatory arena. The session provides an up-to-date cross-disciplinary assessment of the field and trajectories for its future.

W4-D Microbial Risk Assessment Guidelines

The Interagency Microbiological Risk Assessment Guideline is authored by an interagency task group that includes 35 technical staff from USDA, EPA, HHS, CDC, NASA, and DOD. It is intended to be a resource document for U.S. Federal Government microbiological risk assessors, government contractors, and the general microbiological risk assessment community. In recognition of the needs and mandates of different Agencies and the various statutory authorities that may apply to microbiological risk assessment, the Guideline emphasizes a flexible template for conducting microbiological risk assessment. The Guideline is designed to be “modular” in the sense that diverse agencies’ needs can use the fundamentals and only need to add “modules” to provide further specific guidance to their assessors’ particular unique agency needs. The guideline is intended to be a living document and as more information becomes available, it can be modified and appropriate modules added and revised. This session will include: an overview of the scope of the information that is covered in the Guideline, a summary of the concept used for development of the Guideline, examples of how the Guideline is useful for a wide range of probable users, and a discussion on how to use the Guideline. Speakers will present case studies on how the Guideline can be applied within specific media (water, biosolids, air, food) or situations and how the Guideline can be applied along with other Agency frameworks and Guidance that apply to that media or situation. Applications for USDA, EPA, DOD, and NASA will be covered.

W4-I Mercury Exposure and Health Effect Reference Values

Mercury is recognized by the United States and countries throughout the world as a health and environmental problem on local, regional and global scales. The United Nations Environment Programme (UNEP) Mercury Program has acknowledged that the use of mercury in artisanal and small scale gold mining (ASGM) is a leading global emission source (18% of total global anthropogenic emissions) and has focused activities to reduce emissions of mercury from this source. UNEP has estimated that 10 million miners and 3 million women and children in over 70 countries are directly involved in

ASGM globally with an unknown number of others indirectly exposed to mercury through several pathways, including inhalation of mercury vapor and ingestion of fish. A percentage of the emitted mercury deposits in water bodies, is converted into organic mercury compounds and then transported and bioaccumulated in the aquatic foodweb. Another fraction of the emitted mercury travels through long range atmospheric transport, depositing regionally as well as contributing to the global pool, which ultimately deposits in other countries. Despite the importance of this sector to the global mercury cycle, scientific understanding of the scale, characteristics and health risks of mercury emissions from the ASGM sector are poorly understood. To help address this gap in the literature, a series of five presentations have been developed. An introductory talk provides much of the policy context for all of the technical talks. A second talk reviews the available health effect reference values for elemental mercury inhalation exposures, allowing comparisons of those values to historical and current case studies in ASGM, discussed in two other talks in this series. The final talk describes an approach to reduce the emissions in gold processing and, thus, reducing mercury inhalation exposure. The series also points the way to further research in applicable areas. [This abstract does not reflect EPA Policy.]

ABSTRACTS

T3-B.2 Abbott LC; lcabbott@starpower.net

US Department of Agriculture

CHARACTERIZING UNCERTAINTY: INSIGHTS FROM NATURALLY OCCURRING NANOSCALE STRUCTURES IN FOOD AND OTHER LINES OF EVIDENCE

Characterizing and communicating uncertainty - a critical part of any risk analysis - becomes a crucial task when there are many sources and types of uncertainty. Oral toxicity of ENM and potential dietary exposure to these materials is not as well studied as other ENMs that enter the human body through inhalation or dermal exposure. Despite the lower number of research studies on ENM taken up through dietary exposure, there are other lines of evidence that could be used to fill the data gaps in our understanding of ENM in food. This presentation discusses some of the sources and types of uncertainty associated with ENM in food and proposes other lines of evidence from the behavior of nanoscale entities in food and the design of orally delivered nanopharmaceuticals, as well as the previous speaker's discussion of nanoscale entities in the GI tract, that could reduce some of the uncertainty associated with assessing ENF in food. Naturally occurring nanoscale entities are found in food and in some cases have a long history of human consumption. Nanoscale properties of naturally occurring entities in food and orally delivered pharmaceuticals are enumerated and their relevance to ENM are discussed. Finally, a tiered approach to evaluating ENM in food is presented.

M4-E.5 Akhtar R, Santos JR; joost@gwu.edu

GWU

DECISION ANALYSIS TOOL FOR ASSESSING HURRICANE IMPACT ON REGIONAL WORKFORCE PRODUCTIVITY

Natural disasters, like hurricanes, can cause damage to properties and critical infrastructure systems, can degrade economic productivity, and in extreme situations can lead to injuries and fatalities. Workforce disruptions in the aftermath of a hurricane can severely degrade regional productivity because the majority of business operations are labor-dependent. In this research, we develop a workforce recovery model based on input-output analysis to study the interdependent effects of various hurricane intensities on Virginia's workforce productivity. Based on our simulated hurricane scenarios, service sectors in Virginia suffer the largest workforce productivity impact-accounting for nearly 40% of the total economic losses. Sensitivity analysis of parameters relating to workforce inoperability and economic losses can provide insights on identifying and prioritizing critical workforce sectors to expedite disaster recovery.

W3-F.1 Allen Catellier JR, Yang J; jrallen@buffalo.edu

University at Buffalo

RISKY BUSINESS: AN ANALYSIS OF THE TOYOTA RECALL

Toyota's recall of more than eight million vehicles in 2009 and 2010 caught the attention of drivers, automakers, and governmental officials after stories of unintended acceleration and failing breaks began to surface. This study examines media coverage of this recall, specifically looking at the ways in which risk was communicated and the changes in the coverage over a seven-month time frame. To determine the impact that the communication may have had on public perception and reaction to the recall, the social amplification of risk (SAR) framework was used. The analysis showed that over time, the amount of coverage increased substantially, with more than 10 times the number of articles found in the second half of the coverage compared to the first half. In addition, the type of information provided became much more diverse in terms of the number of sources quoted, themes and topics presented, impacts discussed, explanations provided, and solutions presented. This change in coverage, when examined within the SAR framework, suggests that the news media might have served as a potential risk amplification station in the communication of risk and safety information related to the Toyota Recall. However, this information is primarily framed as being safety-related, instead of risk-related, which creates the possibility that the risk information may have been interpreted differently. Future research is suggested to further investigate the conjectures linking media coverage and public response to this crisis.

M4-A.1 Altemose B; baltemose@sabresafety.net

University of Medicine and Dentistry of New Jersey

AN ALTERNATIVE APPROACH TO REDUCE WORKPLACE CHEMICAL EXPOSURE RISKS

In the United States, the primary basis to determine whether workplace exposures are acceptable has been to collect relatively few samples for a limited number of chemicals that have occupational exposure limits. As supported by insights gleaned from 30 years of Occupational Safety and Health Administration (OSHA) air sampling measurements that have recently been made public, several fundamental shifts in thinking must occur if we want to improve our chemical exposure risk assessments in the workplace. First, we must recognize that for most chemicals in the workplace an occupational exposure limit does not currently exist and hazard banding methods such as those set forth in the British Control of Substances Hazardous to Health Regulations (COSHH) or the European Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) regulations must be considered. Second, we need to understand the limitations of these hazard banding approaches, the existing expo-

sure limits, and our professional judgment, which implies the need for better modeling of exposure, better techniques to evaluate dose-response in the workplace, and more exposure data when the banding or judgment predicts an exposure proximate to the exposure limit or band. Third, our regulators and safety and industrial hygiene professionals need to better understand the statistical implications of log-normally distributed exposure data, where a few low results do not necessarily imply compliance or a low exposure risk. Along these lines, we need to reconsider our criteria for acceptable employee exposure distributions, which should be based on the chemical's risk profile and include statistical considerations. Fourth, the implementation of effective engineering controls must occur more consistently and for a much larger number of chemicals. Finally, cost/benefit analyses should be used to identify the best opportunities for risk reduction per dollar spent on controls.

T3-E.3 Amekudzi A; adjo.amekudzi@ce.gatech.edu

Georgia Institute of Technology

RISK AS A BASIS FOR DETERMINING SUSTAINABLE DEVELOPMENT PRIORITIES: A MODEL FOR SETTING SUSTAINABLE DEVELOPMENT TARGETS AND STANDARDS

Several unsuccessful attempts to adopt global standards for sustainability measures allude to the difficulty of obtaining consensus on uniform standards for societies or stakeholders that have different economic, environmental and social quality of life priorities and constraints. A review of the sustainable development and sustainable infrastructure literature confirms the existence of conceptual and operational definitions of sustainable development, much like the concept of economic development. The existence of contextual priorities and constraints indicates that models that embrace contextual differences are more likely to help with the development of consensus on sustainable development or sustainability targets at various levels of decision making: global, national and regional. This paper presents a risk-based approach to determining operational definitions of sustainable development in the context of civil infrastructure development, and applies the model to data from selected countries to demonstrate a data-driven approach to determining sustainable development priorities. The author discusses how such development priorities can be used as a basis for developing consensus on targets for a range of sustainable development measures to promote system-wide progress toward sustainability. The implications of such a model are discussed in the broader context of effective policy development to promote global sustainable development.

M2-D.4 Andersen MA, Budinsky RA, Maier MA, Patterson J, Preston RJ, Rowlands JC, Willis AM; patterson@tera.org

The Hammer Institutes for Health Sciences, Dow Chemical, US Environmental Protection Agency, Toxicology Excellence for Risk Assessment

REPORT OF A WORKSHOP ON DOSE-RESPONSE APPROACHES FOR NUCLEAR RECEPTOR-MEDIATED MODES OF ACTION

The presence of threshold effects for non-cancer and (in appropriate cases) cancer has been the dominant paradigm for the practice of risk assessment. The application of dose-response modeling approaches that include a threshold has been recently questioned. A workshop to explore the development of dose-response approaches to nuclear receptor-mediated liver cancer, including biologically-based dose-response models for key events leading to apical outcomes for tumor promoters was held in the fall of 2010 at the NIEHS. Case studies discussed were: AHR, CAR/PXR, and PPAR α . For each case study a diverse panel of experts from academia, industry, government and other scientific organizations evaluated the key events leading to the apical outcomes. Each panel addressed key questions, including whether the biology of nuclear receptors necessitates a minimum threshold of ligand to be available for activation of a receptor in order to affect gene expression; whether a minimum threshold of receptor ligand is required for any induced effects and subsequent biological and toxicological responses; and, whether linear low-dose modeling is appropriate, based on the underlying science of nuclear receptor signaling biology. The Human Relevance Framework for addressing mode of action (MOA) provided a weight-of-evidence approach for evaluating these charge questions against the available data. A significant objective of the expert panel discussions was to address nuclear receptor MOA information with an eye towards the emerging Toxicology Testing in the 21st Century recommendations of a recent NRC report. Several consensus opinions were recorded regarding dose-response implications of receptor biology with incorporation of MOA data, along with identification of data gaps in the underlying MOA data and dose-response modeling tools. The public workshop had broad support and funding from industry, government, universities, scientific societies, and research organizations.

M3-F.1 Andrade JD; joe.andrade@utah.edu

University of Utah

ENGAGING GENERAL PUBLICS IN INFORMAL ENVIRONMENTS

There is a great need in improving the awareness and education of the general public in Risk, Choice, Chance, Decision-making and allied areas. Risk 'communication' must go far beyond traditional communication tools and strategies to motivate, empower and facilitate effective public awareness, education, and understanding. Modern science centers, museums, and related informal environments are ideal partners and resources with which to access, engage, and involve the greater public. Ex-

isting interactive exhibits on Risk! and Fear will be noted as well as novel approaches to personalize risk awareness and decision making, including a FACES approach to health and risk data based on the book Know Your Chances: Understanding Health Statistics, 2008. Much of the time will be allocated to dialogue with session attendees.

T3-E.2 Andrić E, Guo Z, Haimes YY; ea2r@virginia.edu
University of Virginia

QUANTIFICATION OF THE RISK FUNCTION FROM SYSTEM VULNERABILITY AND RESILIENCE THROUGH BAYESIAN ANALYSIS

The U.S. Department of Homeland Security has been involved for years in the protection of national critical infrastructures. The major challenges of these infrastructures in terms of risk assessment, management, and communication have been and continue to be their vulnerability and resilience. There appears to exist a confused understanding of the relationship between the vulnerability and resilience of a system and its risk to a particular threat. On the basis of this inadequate understanding, several federal and state agencies have been developing varied conflicting risk functions. This paper develops a system-based approach and applies Bayesian principles to relate the vulnerability and resilience of a system for a specific threat, to the quantification of consequences, and thus the risk function. It answers the question: Given a particular attack at a given time, what is the probability distribution of the resulting consequences, based on the vulnerability and resilience of the system? Recall that both the vulnerability and resilience of an infrastructure system are manifestations of the states of the system. It is this realization that serves as the building block for the methodology presented in this paper. To better communicate with the reader, the paper presents a specific example detailing the computational process that relates the vulnerability and resilience of a system to the risk function for a specific threat through Bayesian analysis.

T3-F.4 Anissimov M; anissimov@singinst.org
Singularity Institute

PUBLIC SCHOLARSHIP FOR GLOBAL CATASTROPHIC RISKS

Global catastrophic risks (GCRs) are risks that threaten civilization on a global scale, including nuclear war, ecological collapse, pandemics, and poorly understood risks from emerging technologies such as nanotechnology and artificial intelligence. Public perception of GCRs is important because these risks and responses to them are often driven by public activities or by the public policies of democracies. However, much of the public perception is based on science fiction books and films, which unfortunately often lack scientific accuracy. This presentation describes an effort to improve public perceptions of GCR through public scholarship. Public scholarship is the process of bringing academic and other scholarship into the public sphere, often to inform democratic processes. The effort described here works on all GCRs and focuses on emerging technologies such as biotechnology and nanotechnology.

The effort involves innovating use of blogs, social networking sites, and other new media platforms. This effort has already resulted in, among other things, a visible online community of thousands following the science around GCRs, and plans to further move discussion of scholarly GCR literature into the mainstream media. It is believed that public scholarship efforts like these can play important roles in societal responses to GCRs.

M3-F.2 Anter M, Andrade JD; manter@theleonardo.org
The Leonardo

RISK AND FACES: THE LEONARDO PERSPECTIVE

The Leonardo (www.theleonardo.org) is a new highly interactive science and art center opening in 2011 in downtown Salt Lake City. Risk, uncertainty, probability, and decision making has been considered in the planning and design of several activities and exhibits. Some of these have been applied and evaluated via existing, operational outreach programs - especially The Leonardo on Wheels, STEMWorks, and Faces of Safety - and via web-based interactive experiences: www.theleonardo.org/onwheels/exhibitpreview/chances_are/ <http://www.theleonardo.org/facesofsafety/> Much of the time will be allocated to dialogue with session attendees.

W4-H.3 Anton WR, Edwards JM, Kundrot CE, Robotham KO; craig.c.kundrot@nasa.gov

NASA Human Research Program, Futron Corporation, Wyle Integrated Science and Engineering ANALYSIS STRATEGY FOR RISK ASSESSMENT OF HUMAN HEALTH RISKS PORTFOLIO

The human system is likely the most intricately designed system on the planet. As a result, risk assessment of the human system is complex and poses additional challenges beyond traditional assessments of systems engineered by humans themselves. The Human Research Program (HRP) at the Johnson Space Center (JSC) was formed in order to help the National Aeronautics and Space Administration (NASA) "...focus its research investment on investigating and mitigating the highest risks to astronaut health and performance in support of exploration missions." Currently, HRP has identified a portfolio of at least 27 risks. While the caliber of research conducted within HRP may be unparalleled, HRP program managers are challenged with efficiently managing the research investment across this risk portfolio given their allotted resources. In a document entitled "Agency Risk Management Procedural Requirements" (NASA NPR 8000.4A), NASA defines risk as "...the potential for performance shortfalls, which may be realized in the future, with respect to achieving explicitly established and stated performance requirements." This paper describes a Decision Management Solution (DMS) strategy for effectively empowering HRP program managers with the Risk-Informed data they need to understand the potential for performance shortfalls and thereby make better program management decisions. The strategy is twofold: first, utilize qualitative assessment techniques

to provide higher level but useful risk management information and second, utilize quantitative assessment methods in developing more detailed risk mitigation strategies that can improve overall risk posture.

T4-F.4 Aoyagi-Usui M; aoyagi@nies.go.jp

National Institute for Environmental Studies

UNDERSTANDING CLIMATE CHANGE ISSUE AND GENDER: A RESULT FROM GROUP INTERVIEW ON JAPANESE UNIVERSITY STUDENTS AND GRADUATES IN TOKYO METROPOLITAN AREA

Gender aspect for perception and understanding of risk issues is seldom discussed in Japan. But, many survey results have shown gender differences in perception, and understanding of risk issues. We take climate change issue as an example, and carried out a group interview survey on undergraduate student in mid-June, 2006, and adults in mid-twenties and mid thirties a year later. Students were recruited from universities in Tokyo metropolitan area, whose majors included from natural science to social sciences. We made up them for five groups, a) natural science major female students group, b) social science female students group, c) natural science major male students group, d) social science male students group, and e) members of various environmental students group. Adults survey was carried out based on above categories except environmental group. So we have five groups of university students, and four groups of mid-twenties & thirties. Unlike the similar group interview survey on general public carried out in mid-February in the same year, their knowledge level of climate change is fairly good. Main points of our survey are as follows. We found significant differences among groups. i) The differences of majors are the connection of issues and economic and social activities in general. Students of social science major tend to recognize climate change issue as the problems of society and economic development, but natural science major students tended to talk climate change science and scientific uncertainties. ii) For the gender aspects, we found much differences among female groups of mid-twenties & thirties. Understanding and “efficacy” of policies are very much depended on their “career perspectives.”

P4.5 Arnold SM, Boogaard PJ, Hughes MF, O’Lone R, Price PS, Robison SH, Schnatter AR; smarnold@dow.com

The Dow Chemical Company, Shell International, United States Environmental Protection Agency, ILSI Health and Environmental Sciences Institute, The Procter and Gamble Company, ExxonMobil Biomedical Sciences, Inc

INTERPRETATION OF BENZENE BIOMARKERS OF EXPOSURE FOR RISK ASSESSMENT

Human biomarkers of exposure such as parent or metabolite concentrations in blood or urine are often reported without any context to the sources of exposure or the implications for human risk. The Biomonitoring Technical Committee of the International Life Sciences Institute/Human and Environmental Science Institute

(ILSI/HESI) developed a case study to relate measured human biomarkers to human risk. Although the committee selected benzene as an example compound, the approach is generally applicable to other compounds. Benzene in blood or benzene and its metabolites in urine [S-phenylmercapturic acid (SPMA), phenol, catechol, hydroquinone, and muconic acid] were evaluated in approximately 100 reference populations to determine benzene exposure and risk. For non-smokers in the general population, reported levels of urinary benzene, urinary SPMA, and blood benzene generally reflect the level that would occur from exposure to ambient air benzene concentrations and the USEPA reference concentration. Smokers of the general population frequently exceed this level. At ambient air benzene exposure levels, non-benzene sources (e.g., diet) of phenol, catechol, hydroquinone, and muconic acid can overwhelm the contribution of these compounds from benzene, which frequently obviates the use of these urinary metabolites for evaluating benzene exposure and human health risk. This abstract does not reflect USEPA policy.

M3-E.4 Arnold SM, Bartels M, Burns C, Marty MS, Pitt J, Pottenger L, Saghir S, Ball N, Hollnagel H; smarnold@dow.com

The Dow Chemical Company, Dow Europe GmbH

DERIVATION OF MARGINS OF EXPOSURE FROM HUMAN BIOMONITORING DATA: A CHEMICAL INDUSTRY PERSPECTIVE

Human biomonitoring data are currently available for hundreds of chemicals. The significance of low level detection of these chemicals in humans requires tools to enable interpretation in a risk-based context. As part of The Dow Chemical Company’s (Dow) Product Stewardship Goals, human biomonitoring-derived Margin of Exposure (MOE) values are being developed for numerous high-volume compounds that have both existing animal toxicokinetic (TK) and human biomonitoring data. Correlating animal TK data with validated human biomonitoring information offers a data-driven approach to provide perspective on biomonitoring data and established safe exposure levels for chemicals. The generation of TK data is also being incorporated into many of Dow’s safety evaluation programs, particularly subchronic/chronic and reproductive/developmental animal studies. Animal biomarker levels at a point of departure, such as the no-observed-adverse-effect-level (NOAEL), are obtained for blood and/or urine to correlate with current and future human biomonitoring data generated in either of these matrices. An overview of the methods employed in animal TK measurements, modeling tools to correlate animal and human internal dosimetry data, and MOE calculations are presented.

W2-A.4 Arvidson KB, Yang C, McCarthy A, Cheeseman M; kirk.arvidson@fda.hhs.gov

US Food and Drug Administration

QSAR, TTC AND THEIR APPLICATION TO A VARIETY OF TOXICOLOGY ENDPOINTS FOR FOOD ADDITIVES

Over the past 10 years, FDA's Center for Food Safety and Applied Nutrition, Office of Food Additive Safety (OFAS), in collaboration with FDA's Center for Drug Evaluation and Research Informatics and Computational Safety Analysis Staff has, through various cooperative research and development agreements, acquired access to several quantitative structure activity relationship (QSAR) programs and cheminformatics systems. This software is being used in the evaluation of new food contact materials, food additives, dietary ingredients, impurities and breakdown products. An important aspect to creating better QSAR models is the identification and incorporation of high quality toxicity data into QSAR training sets. To this end, OFAS has begun to capture its historical data in a structurally searchable format and to incorporate this information into existing QSAR models and a new food additives knowledge-base. The food additives knowledge-base is an electronic representation of data and knowledge derived from both OFAS's historical data as well as public sources of toxicity information. The knowledge-base consists of modules of structural alerts and chemical class-driven QSAR models based on biological rules. The structural alerts/chemical classes reflect the categories of threshold of toxicological concerns (TTC), whose threshold values will be stratified across multiple toxicity endpoints allowing for the pre- and post-market evaluation of food additives under a TTC paradigm. Knowledge derived from this evaluation can be used to eliminate unnecessary toxicity testing or to identify new safety concerns as new exposure and toxicity data are incorporated into the model. The knowledge-base modules are designed to be delivered within a configurable workflow management tool.

W1-D.4 Atapattu A; asela.atapattu@ermanz.govt.nz

Environmental Risk Management Authority New Zealand

WHEN IS A SPOON A SPOON? THE PROBLEM WITH VALUING RISKS AND BENEFITS

The Environmental Risk Management Authority (ERMA) regulates the use of new organisms, including insects used for biological control, in New Zealand. The legislation sets out a unique approval system requiring the weighing of risks against benefits in the areas of environment, people's health and the economy with values assigned in cultural and social terms. The success of a regulator is measured by peoples trust and confidence. In an adversarial system, where the regulator has to place values on, and make trade offs between, risks and benefits how does the decision maker maintain the trust and confidence? Assume that someone wants to release an insect for biological control of a weed. This insect is also known to feed, to a limited extent,

on a native plant. How do we assess the significance of the effect on the native plant in a social and cultural context, given that risks and benefits appear, disappear and vary in value depending on your view. For example; A farmer who needs to control the weed places no value on the effect on the native plant; An individual who finds aesthetic value in the native plant places a medium value on the effect on the native plant; An individual who claims the right of guardianship over the plant will place a high value on the effect on the native plant. Given such different views how can a regulator decide what is the 'right' value? How will they recognise the spoon? Our goal is to develop a method that will allow the risk assessor to value the social and cultural consequence of effects in relationship to each other. That is, adjusting for likelihood, a way to compare the cultural and social consequences of weed control, with the cultural and social consequences of a loss of guardianship. Any method that is developed would have to provide a mechanism to calibrate the social and cultural consequence assigned by individuals and must allow the calibration of similar effects. Thus the question is 'Is there a spoon?'

P.88 Augustsson A, Filipsson M, Bergbäck B, Öberg T; anna.augustsson@lnu.se
Linnaeus University

THE ASPECT OF CLIMATE CHANGE IN RISK ASSESSMENTS OF CONTAMINATED LAND

Metals frequently occur at contaminated sites, where their potential toxicity and high persistence require risk assessments that consider possible long term alterations. Such changes are traditionally accounted for by considering alternative land use. However, mobility or bioavailability are also likely to change with time, for example due to climate change. The present study aimed at evaluating the effect of a change in climate on metal exposure at a highly polluted iron and steel works site in Sweden. As the practical relevance is a key aspect in the development and understanding of methods for risk analyses, a commonly used exposure model was chosen for the calculations. The model used has been developed by the Swedish Environmental Protection Agency and resembles the Dutch CSOIL model. Deterministic calculations were made as a baseline for present conditions and a set of future scenarios. The impact of uncertainty and variability in the input parameters was then evaluated by repeating the calculations using probability bounds analysis that combines interval arithmetic and probability to create probability boxes representing not a single distribution, but instead a class of distributions. Although only six of the model parameters (the groundwater infiltration, hydraulic conductivity, the hydraulic gradient, the soil moisture, the Kd value and bioconcentration factors) were assumed to be sensitive to a change in climate, a clear effect was seen on the total exposure. By changing these few variables with 15 - 20%, the total exposure increased with almost 20%. The parameters with strongest influence on the result were the hydraulic gradient, the Kd value and the bioconcentration factors. However, large uncertainties are

always present in analyses of these kinds. So besides addressing the possibility of a significant climate impact on risk assessments, the study highlights yet an aspect of the need of model refinement and indata characterization.

W3-E.1 Avens HJ, Keenan JJ, Unice KM, Paustenbach DJ; dpaustenbach@chem-risk.com

ChemRisk, CO, CA, PA

ESTIMATING THE AIRBORNE CONCENTRATIONS OF BENZENE AND OTHER RELEVANT VOLATILES IN BOATS OPERATING IN OR NEAR OIL SPILLS: A COMPARISON BETWEEN THE EXXON-VALDEZ AND DEEPWATER HORIZON INCIDENTS

The Deepwater Horizon oil spill in the Gulf of Mexico has been noted as already surpassing the Exxon-Valdez oil spill as being the largest in U.S. history. In particular, at the time of this writing, the Deepwater Horizon incident is alleged to be leaking approximately 25,000 barrels a day into the Gulf of Mexico. Concerns have been raised about the degree of human exposure to various volatiles in crude oil including, but not limited to, benzene, ethyl benzene, and toluene. It is not uncommon for persons involved in the recovery efforts or the collection of wildlife for cleaning to be exposed to these vapors while on a boat in these waters. This paper discusses the application of one of the most common oil spill analysis software, ADIOS2 (Automated Data Inquiry for Oil Spills-2), which was developed by the National Oceanic and Atmospheric Administration, in partnership with a number of other federal agencies. The model takes into consideration the key variables such as oil type, wind speed and direction, water temperature and salinity, speed and direction of water currents, wave height, and type and duration of oil release. We not only apply this model but compare the results with available air samples which have been collected during the Deepwater Horizon and Exxon-Valdez incidents. The benefits and disadvantages of utilizing ADIOS2 and other related models are discussed. Additionally, if new information regarding the impact of hurricane-level winds on the airborne concentration of volatiles above oil spills becomes available, that information will be incorporated into our analyses.

M4-D.3 Ayers TL, Hoekstra RM, Cole D; Tayers@gmail.com

Centers for Disease Control

USE OF EPIDEMIOLOGIC PROFILING OF FOODBORNE OUTBREAKS WITH UNKNOWN ETIOLOGY IN THE ATTRIBUTION OF FOODBORNE ILLNESSES TO FOOD COMMODITIES

Despite the discovery of new pathogens and improvements in laboratory detection methods, many foodborne disease outbreaks in the United States are of undetermined etiology. The presenter will describe a method to utilize information from outbreaks with known etiologies to inform foodborne outbreaks of unknown etiology so that illnesses from these outbreaks may be used in estimates of food commodity attribution.

P31 Bailey A, Stelljes M; abailey@slrcorp.com

SLR International Corporation

EXTRAPOLATING FROM EXTRAPOLATIONS - WHERE DO WE DRAW THE (DOSE-RESPONSE) LINE?

To calculate site-specific ecological screening levels, EPA recommends use of the AWQC and Eco-SSL methodologies for aquatic and terrestrial receptors, respectively. Both methodologies combine toxicity values such as NOECs and LC50s with uncertainty factors to derive conservative values for screening in ecological risk assessment. A mean or percentile value may be used if sufficient data are available; if not, the approach defaults to the lowest value. Given the paucity of ecotoxicity data for many chemicals, the resulting value is typically the lowest available. Many studies, however, provide NOECs, LC50s, and similar values that are derived statistically based on dose-response models, rather than actual measured values. While this is often appropriate, for some chemicals these unmeasured values conflict with studies reporting measured effects concentrations. The values are then lowered further by the application of uncertainty factors, resulting in artificially low and overly conservative screening levels that are not supported by actual data. For example, following the AWQC process for ethylene glycol, an LC50 of 4.2 mg/L for nectonic invertebrates is identified and an uncertainty factor (UF) of 5 is required to convert from an LC50 to a LOEC, resulting in a screening value of 0.82 mg/L. In contrast, using measured effects data would result in a reproductive NOEC-based value of 8,950 mg/L, with no uncertainty factor required. This measured value is four orders of magnitude higher than the statistically derived alternative, and yet is much more relevant. For zinc, the AWQC method results in a screening level of 0.014 mg/L based on a calculated LC50 of 0.068 mg/L and a UF of 5, an order of magnitude below the lowest measured NOEC of 0.1 mg/L. Data will be presented to support a weight of evidence approach as a preferred alternative to defaulting to the lowest value, to ensure that accurate and defensible values are incorporated into ecological risk assessments.

W1-A.1 Barrett SM, Penman M, Dederick EJ; sbarrett@icfi.com

ICF International, Penman Consulting

SIEF MANAGEMENT AND DATA SHARING UNDER REACH

The Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) regulation introduced specific mechanisms to enable the chemical industry to share existing information in order to meet registration requirements. One such mechanism is the formation of substance information exchange fora, or SIEFs. Each SIEF provides a forum for sharing information among manufacturers, importers, and downstream users of a substance slated for registration. The objectives of SIEFs are to 1) facilitate data sharing and thereby prevent additional testing, particularly on vertebrate animals, when reliable data are already available, and 2) facilitate information exchange relative to classification and labeling. SIEFs also provide a

platform for stakeholders to organize joint data submissions, although this may also be accomplished via other mechanisms, such as consortia. While REACH was designed specifically for the European regulatory environment, numerous elements of REACH are relevant to the United States and other international chemical regulatory systems. The data exchange and sharing mechanisms may be particularly useful as the United States considers modernization of the Toxic Substances Control Act (TSCA). Data sharing is critical to the success of large-scale chemical regulations such as REACH, and the process by which information can be exchanged is complex. Issues of confidentiality and compensation must be handled with extreme sensitivity. Important lessons have been learned about how to ensure that privacy is maintained and that data owners are properly compensated. A framework for SIEF management and data sharing under REACH is presented. Topics covered include data sharing, cost determination, compensation and reimbursement, letters of access, and the critical role of IT systems. Also included is a discussion of any newly developed TSCA mechanisms for data sharing. Finally, a comparative analysis of the relevance and applicability of REACH data sharing mechanisms to the US regulatory framework will be presented.

T2-H.4 Bass N; Nikki.Bass1@us.army.mil
USAPHC

NANOTECHNOLOGY: DYNAMIC RISK MANAGEMENT FOR AN EVOLVING SCIENCE

Over the past 10 years, the study of nanotechnology has emerged as one of the most promising sciences of our time with applications ranging from food science to pharmaceutical science, mechanical engineering, power generation, and many other new fields. The great potential associated with these technologies has invigorated the scientific community; however, as researchers develop new materials and capabilities it is imperative that the associated risks be identified, assessed and controlled. From the risk assessor's perspective, nanotechnology presents a unique challenge because it encompasses countless chemicals and compounds and many of the traditional analytical methods used to study materials require modification to study nanoscale materials. The Department of Defense has a well established three-tiered process for over-the-horizon scanning for emerging contaminants, conducting impact assessments in five DoD functional areas, and the development of risk management options. This presentation will discuss how DoD's standard emerging contaminant risk assessment process was customized to accommodate the unique characteristics and circumstances surrounding nanotechnology. It will also overview the results of the DoD's first nanotechnology impact assessment and the path forward.

P.18 Bastaki M; bastakim@evergreen.edu
The Evergreen State College

CUMULATIVE RISK ASSESSMENT FOR ESTROGENIC CHEMICALS

Given the number of structurally diverse endocrine-active chemicals and the widespread human exposure to a number of them, the efforts to assess risk from single chemical exposures may significantly underestimate risk of adverse effects and fail to address observed health outcomes. This may also be compounded by relatively high RfD values that are derived using non-sensitive endpoints (body weight, organ weight) and may underestimate the risk of subtle yet functional effects. There is wide acknowledgement of the need to address additive and interactive relationships consistent with realistic exposures scenarios to multiple chemicals from multiple routes. A hazard index approach was employed to assess the cumulative risk from low-dose multiple chemical exposures to a number of estrogenic and antiestrogenic chemicals. Their relative binding affinity for the estrogen receptor alpha (ER α) was used as a tool to derive relative potency factors compared to 17 β -estradiol. The lowest effective dose in vivo was used as a point of departure from which an acceptable level of exposure for each chemical was derived with application of relevant uncertainty factors. Only chemicals that have tested positive for estrogenicity in both the in vitro receptor binding and in vivo uterotrophic assay were assessed. Estimates of median and upper 90% exposures to the same chemicals were obtained from the literature. Assuming a common mechanism of action (estrogen receptor binding) a dose-addition approach was used to derive a cumulative estimate of risk. A cumulative risk assessment is warranted to adequately characterize the risk from realistic exposure scenarios to multiple chemicals.

W4-A.2 Baum SD; sethbaum@gmail.com
Pennsylvania State University

SPACE-TIME DISCOUNTING, GLOBAL CATASTROPHIC RISK, AND CLIMATE CHANGE ECONOMICS

Discounting and global catastrophic risk (GCR) have been identified as crucial elements of climate change economics. In economic models, optimal climate policy is usually highly sensitive to the discount rate. However, the risk that climate change could bring global catastrophe can dominate even the choice of discount rate. This presentation offers new perspective on the relationship between discounting, GCR, and climate change economics grounded in a new theoretical conceptualization of discounting. Whereas discounting is traditionally conceptualized as the comparison of values across time, the new discounting theory compares values across both space and time. The new theory shows that discounting can dominate GCR in analysis of climate change and other risks, but only under extreme discounting assumptions. Furthermore, certain forms of space-time discounting can actually lead to increas-

es in GCR. However, there are strong ethical arguments against such discounting. These arguments indicate that GCR reduction should be a top individual and societal priority.

P.72 Bayramov AA; azad.bayramov@yahoo.com

Institute of Physics Azerbaijan National Academy of Sciences

NUCLEAR FORENSICS THREAT RISK ASSESSMENT

Nuclear attribution is the process of identifying the source of nuclear or radioactive material used in illegal activities, to determine the point of origin and routes of transit involving such material, and ultimately to contribute to the prosecution of those responsible. Nuclear forensics (NF) is the analysis of intercepted illicit nuclear or radioactive material and any associated material to provide evidence for nuclear attribution. The goal of nuclear analysis is to identify forensic indicators in interdicted nuclear samples or the surrounding environment, e.g. the container or transport vehicle. The aim of NF threat risk assessment is to better understand the existence and nature of the possible dangers presented by insiders, internal groups, and external groups that may seek unauthorized access to nuclear materials from sources inside the nation or that may try to use the nation's transportation systems or geography as part of a illicit transport system to move contraband nuclear materials from one point to another. So, the goal of our investigations is a development of the model of Nuclear Forensics Threat Risk Assessment on the basis of NF databases including different scenarios and performance of threat risk assessment of illicit trafficking of nuclear materials and calculation risk of illicit trafficking of nuclear materials in Azerbaijan.

W3-B.3 Beaudrie CEH, Satterfield T, Kandlikar M, Herr Harthorn B; christian.beaudrie@gmail.com

University of British Columbia

BENEFITS, RISKS, AND REGULATION OF NANOMATERIALS: RESULTS FROM AN EXPERT SURVEY

Continuing uncertainty about the potential risks of nanotechnology means that expert opinion will play an important role in assessing and regulating risk. We present the results of a web-based survey (n=2,100) of three pools of US and Canadian experts: nano scientists and engineers (NSE), nano EHS scientists and toxicologists (NTOX), and scientists and regulators in government agencies (NREG). This research aims to shed light on the views of various groups of 'nano experts' to better understand which nanomaterials or applications are viewed as more risky than others, and to understand the implications of these findings for future nanomaterial regulation. Furthermore, this work aims to characterize differences in judgments between experts to evaluate how variables such as experience, research institution, career stage, and disciplinary background might influence the perceptions of risks and benefits from emerging nanotechnologies.

W1-A.4 Becker RA; Rick_Becker@americanchemistry.com

American Chemistry Council

MODERNIZING TSCA: LEVERAGING LESSONS LEARNED FOR ASSESSING CHEMICAL SAFETY

Harnessing the considerable scientific advances made in the past 30 years for conducting hazard evaluations, exposure assessments & risk characterizations should be a fundamental objective in modernizing the Toxic Substances Control Act (TSCA). There are lessons to be learned from authoritative scientific reviews & regulatory programs in the U.S., Domestic Substances List in Canada, Registration, Evaluation, Authorisation & Restriction of Chemicals (REACH) in Europe. Prescriptive frameworks - one size fits all testing regimens - are no longer scientifically supportable. These are rapidly being replaced with integrated testing strategies (ITS), which utilize predictive models, chemical categories, in vitro assays, & other relevant scientifically valid information to estimate toxicological properties in lieu of animal toxicity tests. Within such an ITS, use of a tiered testing framework with toxicity triggers allows for scientifically justified evaluations of commodity chemicals that are comprehensive in terms of hazard identification, minimize use of animals & distinguish data gaps from data needs. Data needs are specific data gaps that actually require additional work before potential risks can be characterized with an adequate degree of scientific certainty; data gaps are elements of an assessment that could benefit from additional data, but such data is not critical. In exposure assessment, it's critical that industry experts both up & down the value chain have appropriate collaboration mechanisms to work together, & that they work with government & academic scientists to develop realistic exposure scenarios & estimates. To leverage the significant resources needed for developing evaluations, those developed for one region should be packaged so that common elements can be readily submitted to regulatory programs in other regions. Clearly, modernization of TSCA can benefit from thoughtful application of experiences gained from REACH & other similar activities.

T3-G.1 Becker RA; Rick_Becker@americanchemistry.com

American Chemistry Council

THE CASE FOR BOTH INDIVIDUAL AND POPULATION TOXICITY THRESHOLDS

The biological bases for thresholds in the induction of pharmacologic and toxicologic effects has long been recognized. The principle of response as a function of the concentration of active agent at the site of action holds in toxicology, just as it does in therapeutics. At the individual level, both empirical and mechanistic analyses speak to thresholds. At the population level, the biological bases for thresholds will be discussed and examples will be presented.

M2-A.3 Belzer RB; belzer@regulatorycheckbook.org

Regulatory Checkbook

RISK ASSESSMENT AND INFORMATION QUALITY: AN EMPIRICAL STUDY OF FEDERAL AGENCY PERFORMANCE, 2010 UPDATE

Legislation enacted in 2000 (the “Information Quality Act,” 44 USC 3516 note (a)) 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. Risk assessment, in its various forms, continues to be the dominant type of information covered by error correction petitions. In 2008, I presented an analysis of five years’ data on a census of 158 error correction petitions submitted during FYs 2002-2007 and analyzed agencies’ adherence to their own procedural rules and performance metrics. Agency performance was shown to vary widely, with some performing superbly while others failing to implement the law at all. Poor performance was widely attributed to petitioners’ apparent lack of standing to obtain judicial review. Nonetheless, I predicted that the courts would 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. This paper extends the data set by three years through FY 2010 and updates agency performance comparisons. In addition, an important recent decision in the Court of Appeals for the D.C. Circuit (Prime Time International, Inc. v Vilsack) puts Information Quality Act compliance at the cusp of becoming mandatory for actions covered by the Administrative Procedure Act. The Court gave Chevron deference to the Office of Management and Budget’s government-wide information quality guidelines (67 Fed. Reg. 8452), and appears to have declined to compel agency adherence only because the information at issue was an adjudication, which is exempt from OMB’s definition of “dissemination.”

P80 Ben-Haim Y; yakov@technion.ac.il

Technion-Israel Institute of Technology

UNCERTAINTY, PROBABILITY AND ROBUST PREFERENCES

Can one reason cogently about uncertainty without invoking, at least implicitly, probabilistic ideas? For most people—including risk analysts, topical specialists, and philosophers—the answer to this question is fairly self evident. The curious thing is that many people answer Yes and many others answer No. I will argue that uncertainty and probability are different, and that cogent reasoning about uncertainty need not rely on probabilistic premises. This is particularly important in those situations—common in risk analysis—where probabilistic evidence is unavailable. In those situations, if cogent thought required probabilistic premisses we would either have to

forego cogency or assume probabilistic propositions arbitrarily (which might itself lack cogency). I will address the questions: does a non-probabilistic robust preference between policy options assume a uniform probability distribution on the underlying uncertain events? Does a robust preference assume SOME probability distribution on the uncertain events? More generally, I will consider the question: What probabilistic assumptions, if any, underlie robust preferences? The answer to all these questions will be No, non-probabilistic robust preferences do not depend upon probabilistic assumptions for their plausible justification. While an infinity of distinct probability assertions lend support to non-probabilistic robust inferences, the reverse is not true. Plausible warrant for robustness can be obtained without appealing to probabilistic reasoning.

T3-I.2 Bennett SP, Levine ES, Waters JF, Purdie AJ, Kolasky BP; steve.bennett@dhs.gov

Office of Risk Management and Analysis, US Department of Homeland Security

WHICH ONE OF THESE IS NOT LIKE THE OTHERS: A SIMPLE, STRUCTURED METHODOLOGY FOR ASSESSING ALL-HAZARDS RISK ACROSS THE HOMELAND SECURITY ENTERPRISE

The Department of Homeland Security’s Quadrennial Homeland Security Review (QHSR) includes a requirement for a Homeland Security National Risk Assessment (HSNRA), a strategic enterprise-wide, all-hazards assessment intended to inform strategic decision making by senior leadership across the homeland security enterprise (which includes, federal, state, local, tribal and territorial entities). Estimating risks from terrorism, cyber attacks, natural hazards, transnational crime, and other homeland security hazards in a holistic assessment is necessitated by the scope and magnitude of homeland security risks facing the enterprise, but brings with it many technical challenges due to the dissimilar nature of these hazards. In this presentation, we will describe several key aspects of the methodology design for the assessment such as planned elicitation approaches, thinking for determining the granularity and scope of the corpus of scenarios to be evaluated, and approaches for consequence estimation and modeling. In addition, we will discuss possible novel approaches for estimating the likelihood of terrorism such as approximate reasoning approaches, and methods for incorporating “intelligent adversary” modeling such as game theoretic attacker/defender models, as well as notional HSNRA outputs and risk management recommendations.

T3-F.1 Berube DM; dmberube@ncsu.edu

North Carolina State University

EMERGING TECHNOLOGIES AND RISK ANALYSIS

Nanoscience and nanotechnology is on the brink of exploding onto the market as a platform technology for a plethora of applications, especially in energy, environmental remediation, and medicine. Advances in emerging sciences and technologies

such as neurotechnology and synthetic biology may appear on the market in the near future as well. The environmental health and safety (EHS) footprint of nanoscience and other emerging sciences and technologies (EST) remain uncertain nonetheless the trend toward commercialization advances at a tremendous rate. In addition, globalization threatens hastened product development ahead of efforts to secure safety workplaces and quality control. Technological paradises can be found throughout the developing world: places where EHS is less a concern than meaningful employment. Risk management is difficult in ambiguous situations and it will be acutely challenged in the near future by nanoscience unless efforts are undertaken to develop new tools for risk assessment and management. We are watching the risk management world attempt to analyze EST risks with incomplete and inexact data sets. Given the nature of EST it is nearly impossible to produce the level of certainty needed for conventional risk algorithms. We are approaching a breaking point whence we must ask whether it is time for wholly new ways to assess and manage risks. These new forms of assessment will need to accommodate both the rate of change as well as the heightened levels of uncertainty. New models of assessment will enable new dialogues over regulatory options: opportunities for banding as well as new versions of precaution may become viable. This paper examines early work to create new algorithms to study risk in cases of EST. Drawn from a decade of studying risk especially as it related to nanoscience, this author anticipates new developments in risk assessment methodologies.

P.68 Besley JC; jbesley@sc.edu

University of South Carolina

IMAGINING PUBLIC ENGAGEMENT

As exploratory research, two separate studies looked at how student samples conceptualized public engagement about nuclear power or nanotechnology. Study 1 (n = 267) involved the quantitative coding of an open-ended question embedded within an experiment and found that participants had a broad range of ideas about what public decision-makers might do to consult the public. However, most of the mechanisms described by respondents involved very little opportunity for actual dialogue. For example, about 2/5 of respondents indicated that they thought decision-makers would consult the public by seeking media coverage through a press release or news conference. This was the most common response. Similarly, the second most common response was that government would use a survey to consult the public. About 1/5 of respondents gave this response. Also, about half of respondents indicated some negative feeling about public engagement even though the question did not ask for an affective evaluation of engagement. Study 2 (n = 187) tested a novel 'draw a meeting test' - based on the widely used 'draw a scientist test.' Whereas study 1 found a wide range of ideas about what might be involved public engagement, study 2 found substantial homogeneity in participants' engagement descriptions. As

with study 1, however, participants saw little opportunity for meaningful engagement with risk decision-makers. Specifically, when asked to describe a public meeting, respondents drew a traditional classroom format with experts in front of an audience. When asked to divide up a three hour meeting, respondents allocated only about one hour to public questions or comments. Independent coders did all coding and achieved high levels of interceding agreement for both studies. The research highlights the potential value of broader research focused on how citizens envisage public meetings and speaks to the need to further test the impact of public engagement perceptions on willingness to engage.

M4-C.3 Besley JC, McComas KA; jbesley@sc.edu

University of South Carolina

SUPPORT FOR NUCLEAR POWER AND THE PERCEIVED FAIRNESS OF GOVERNMENT, INDUSTRY AND UNIVERSITY DECISION-MAKERS

The study reports on a spring 2010 national survey (n = 530) that sought to assess current views about nuclear energy in the United States. The survey is unique in that it focused on respondents' perceptions of the fairness of decision-makers across three types of institutions, including government, industry, and universities. Additional questions included in the survey enable consideration of gender, race, education, age, attention to debates about nuclear energy, and concerns about health and environmental risks of nuclear power (all non-demographic measures were assessed using multiple measures). In addition to describing present attitudes, the analysis explores the relative advantages of looking at a single overall measure of fairness for each institution versus focusing on separate measures of distributive, procedural, interpersonal, and informational fairness. The analysis also provides evidence related to debates about the interactive effect of fairness concerns and the perceived morality of nuclear energy development. The results show that, while perceived risks and benefits of nuclear power are the biggest predictors of support for nuclear energy, overall views about the fairness of a range of actors is also key. The results further highlight a significant interaction between views about the fairness of government and morality. In this regard, it appears that seeing nuclear energy as a moral issue and seeing the government as fair amplifies support for nuclear energy beyond what would be expected by morality views and views about government alone. The data is put in context of two additional surveys about nuclear energy from 2007 and 2008 by the authors, recent work by other scholars on nuclear energy and related work on other technologies. The results speak to the need for those communicating about risk to emphasize the fairness of decision-makers alongside traditional risk and benefit issues.

T2-E.2 Bier V, Hausken K; kjell.hausken@uis.no
University of Wisconsin, Madison, University of Stavanger, Norway

DEFENDING AND ATTACKING NETWORKS SUBJECT TO TRAFFIC CONGESTION

We consider a population of drivers who choose the most time-efficient of two arcs (possibly of different lengths) from a start node to an end node. Both arcs are subject to traffic congestion, and also to blockage or disruption (e.g., by a terrorist attack). The model has three strategic actors, the government, the terrorist, and the drivers. The government allocates a fixed resource to protect travel along the two arcs, while the terrorist allocates a fixed resource to disrupt travel along the two arcs. The drivers choose the arc that gives the shortest travel time, and cannot choose a blocked arc. There are three possible outcomes: both arcs operate; one arc operates while the other is blocked; or both arcs are blocked. The drivers have reservation travel times such that if an individual driver's reservation travel time is exceeded, the driver prefers not to travel; the reservation travel times vary among drivers, and are uniformly distributed between a minimum and a maximum value. In equilibrium, if both arcs are operational, the drivers distribute themselves across the two arcs so that the travel times along both arcs are equal; if only one arc is operational, they distribute themselves between driving and not driving so that the reservation travel times of the non-travelers are less than the travel time on the operational arc, and the reservation travel times of the travelers are greater than the travel time. The objective function, which the government minimizes and the terrorist maximizes, weights the travel times by the number of drivers along the two arcs, and weights the average penalty (which equals the trip value) suffered by those preferring not to travel by the number of drivers who do not travel.

M2-I.2 Bier V.M., Wang M; bier@engr.wisc.edu
University of Wisconsin Madison

ELICITATION OF EXPERT OPINIONS ABOUT TERRORIST PREFERENCES

We discuss how to construct a reasonable defender prior distribution over possible terrorist preferences, by explicitly modeling the defender's uncertainty about both the weights assigned by the terrorist to various observed attributes, and also the value of any unobserved attributes (i.e., target attributes that may be important to the terrorist, but are unknown or unobserved by the defender). In particular, in our proposed model, a centralized decision maker assumes that the terrorist evaluates target attractiveness according to a multi-attribute utility function, with an "error term" representing the effect of any unobserved attributes. To estimate the parameters of this model, multiple experts are asked to rank the set of potential targets in terms of their attractiveness to the terrorist. The decision maker can then make inferences both about the weights of the various known attributes, and about the importance

of the unobserved attributes, using either probabilistic inversion or Bayesian density estimation. This process not only gives rise to reasonable prior distributions for terrorist attribute weights even in the face of conflicting or inconsistent expert opinions, but can also be used as a basis for inferences about what some of the unobserved attributes might be. For example, if Los Angeles, Las Vegas, and Orlando are all rated more highly by many experts than their known attribute values would suggest, that might indicate that presence of a large entertainment industry could be an attribute in the terrorist's utility function.

W2-C.1 Biksey TM; thomas.biksey@wspgroup.com
WSP Environment, Energy and University of Pittsburgh

LCA PILOT STUDY: WATER USE AND WATER QUALITY FOR CORN VERSES CELLULOSIC ETHANOL

The proposed strategy by the U.S. Environmental Protection Agency (EPA) to increase the supply of renewable fuels, as mandated by the Energy Independence and Security Act (EISA) of 2007, will result in the production of approximately 36 billion gallons by 2022. The EPA strategy notes that increasing renewable fuels will reduce dependence on foreign oil, and will reduce greenhouse gas emissions. This pilot study evaluates water quality and water consumption needs from feedstock production, through biofuels production, coproducts, and final ethanol product for corn-based versus cellulosic-based feedstock using the life cycle assessment process and risk assessment paradigm. The object is to develop the technical approach for indicators and metrics, that will then be applied to an expanded life cycle assessment that includes other environmental indicators (releases to environmental media, land use, and soil quality) and public health indicators (air quality, mycotoxins, and food scarcity), using indicator-specific metrics for environmental and public health. The results of the public and environmental health model are used to formulate recommendations that can inform public policy regarding the implementation of EISA.

W3-F.2 Binder AR, Liang X, Brossard D, Scheufele DA, Gunther AC; arbinder@wisc.edu

University of Wisconsin-Madison

RECONSIDERING RISK AMPLIFICATION: CONTENT ANALYSIS OF THEMATIC EMPHASIS IN NEWSPAPER COVERAGE OF A PROPOSED BIOLOGICAL RESEARCH FACILITY

The notion that mass media are a primary communication channel through which the public is exposed to information about risks is a central assumption of the risk communication literature. Existing research, however, lacks a systematic understanding of how certain risks first come to receive news media attention and how they are subsequently treated in reports. With this study, we apply the concept of "amplification station" to media coverage of the site-selection of a new biological research laboratory in the United States. We focus on both (1) analyzing risk as one

of many possible attributes of the facility and (2) comparing across different community contexts. The data for this study comprise every published newspaper item that mentioned the biological research facility in three communities over a 37-month period. Using this total database of nearly 1,100 news items, we employed computer-assisted content analysis to identify four specific risks and four specific benefits that may have been mentioned in association with the facility. Two phases of analysis were undertaken. First, we looked at the relative longitudinal prominence and cumulative growth of three generalized thematic emphases: unique risk, unique benefit, or a combination of risk and benefit. Second, we analyzed these patterns according to different types of newspaper content (e.g., news articles, editorial content, and letters to the editor). The patterns that emerged across the three communities lend little support to idea that news media consistently amplify risks more than other attributes of a salient policy issue. Rather, the patterns reflect complex relationships between community structures (e.g., news outlets and government agencies), individuals within those structures (e.g., journalists and officials), and audience feedback. Amplification of risk occurs only if specific sufficient conditions are met within these relationships. Implications for risk communication and public understanding of science are discussed.

T2-F.3 Boerner F, Schuetz H, Wiedemann P; francesca_borner@hotmail.com
Kassel University

TESTING EVIDENCE MAPS: RESULTS FROM A SERIES OF EXPERIMENTS

The way risk assessment data is reported to non-experts, can have a profound impact on risk perception and trust in risk assessors. Therefore, scientific evidence characterization presented to non-experts should give a transparent and easy to grasp overview of the state of evidence. However, scientific reports are often presented in difficult to read and difficult to understand unstructured text-formats (for example SCENIHR Report on RF-EMF, 2009). The evidence map approach from Wiedemann, Schütz & Spangenberg (2008), tries to provide a structured graphical information tool for presenting risk assessment data to non-experts. So far, this approach has a good acceptance among the experts, providing a useful structure for discussion and facilitating comparisons across the topic areas (e.g. regarding methodological standards). In this presentation we provide more detailed information about a number of experimental studies conducted in order to investigate whether specific graphical characterization tools (evidence maps) are useful for informing non-experts. The experimental studies had one factor (narrative text versus evidence maps) and were carried out with different sets of students in Austria and Germany. The students had to rate understandability, comprehensibility and readability of the two different texts. The results will be discussed regarding the differences between the two text formats and the impact on risk communication and the presentation of risk assessment data to non-experts.

P.87 Bogen KT; kbogen@exponent.com
Exponent

GENERIC HOCKEY-STICK MODEL PERFORMS AS WELL OR BETTER THAN USEPA BENCHMARK DOSE METHODOLOGY

Benchmark Dose Software (BMDS), developed by the U.S. Environmental Protection Agency, applies a growing suite of models and decision rules to characterize non-cancer and cancer dose-response, but provides no assurance concerning statistical performance. As typically applied, BMDS also ignores the possibility of reduced risk at low doses ("hormesis"). A simpler, proposed Generic Hockey-Stick (GHS) model also estimates benchmark dose and potency, and also characterizes and tests for hormetic trend. Using 100 simulated dichotomous-data sets (5 dose groups, 50 animals/group), sampled from each of seven risk functions, GHS estimators performed about as well or better than BMDS estimators, and surprisingly the BMDS approach mis-specified all of six non-hormetic sampled risk functions ~90% of the time on average. When applied to data on rodent tumors induced by the genotoxic chemical carcinogen anthraquinone (AQ), the GHS model yielded significantly negative estimates of net potency exhibited by combined rodent data, suggesting that-consistent with the anti-leukemogenic properties of AQ and structurally similar quinones-environmental AQ exposures pose no net cancer risk. In addition to simplicity, flexibility, and reliability, the GHS approach offers a unified, consistent approach to quantifying environmental chemical risk.

T3-F.2 Bostrom A, Hudson R, Scharks T, Gilliland R; abostrom@u.washington.edu
University of Washington

CHARACTERIZING MENTAL MODELS OF EMERGING NANOTECHNOLOGIES: A NANO SUNSCREEN STUDY

Applications of nanotechnology are proliferating, such as the use of nanoparticles of titanium dioxide and zinc oxide in sunscreen to shield against UV radiation. Nonetheless, a 2009 meta-analysis by Satterfield and colleagues estimated that 51 percent of survey studies respondents (mostly in North America) had heard nothing about nanotechnology. What mental models, then, if any, are driving their decisions and risk judgments, and is it possible to characterize them? Increased interest in assessing the risks of nanoparticles from consumer applications makes sunscreen fertile ground for the study of mental models of nanotechnology. While several public dialogues and focus group studies have addressed the use of nanomaterials in cosmetics, to the best of our knowledge no published studies have assessed individual consumers' mental models and associated perceptions of the risks and benefits of nanotechnology in sunscreens. In this paper we report the results of semi-structured nanotechnology mental models interviews that begin with a sunscreen comparison and choice task (N=6; 4 men, 2 women, aged 21 to over 60). Participants' charac-

terizations of and inferences about nanotechnology in the opening section of the interview stem primarily from beliefs about size (extremely small) and science fiction-derived ideas about nanomachines. Five concepts appear frequently in the pilot interviews, and characterize participants' mental models of nanotechnology: small size, nanomachinery, human and environmental health effects (both possible benefits and possible risks), and that FDA should regulate nanotechnology. Although almost all participants mention potential human health and environmental effects, most of the specific potential exposure (source and pathways), health and environmental effects, and mitigation concepts in risk analyses are not mentioned by respondents and do not enter into their thinking about sunscreens or about nanotechnology. We expect similar findings in the larger mall-intercept sample now being collected.

M3-C.1 Boudier FB, Lofstedt RE; f.boudier@maastrichtuniversity.nl
Maastricht University

CAN WE STILL TRUST THE REGULATOR? LESSONS FROM HSE'S RISK COMMUNICATION OF ONSHORE OIL LEAKS

The UK regulator of occupational safety (HSE), has played a key role in promoting "best practice" on risk management and communication (HSE 1989; HSE 2002; Boudier et al. 2007). For a long time, it has been perceived as a fair and economically-neutral actor (Pidgeon et al. 2003). Is it still the case? Since the mid-2000s a number of public stands have exposed the Executive to criticism, from suggestions that it is failing in its duty to protect the public in some areas, to suggestions that it is being risk-averse, tedious and cumbersome in others (Jenkins 2006; House of commons 2008). Is UK health and safety model at jeopardy? Could HSE revisit its communication approach to maintain trust in the regulatory process? This paper analyses the critical case of "onshore oil/gas leaks", focusing on the Buncefield oil storage depot incident of 2005, described at the time as the largest incident of its kind in peacetime Europe. The main conclusion is that HSE tends to apply a standard approach to risk communication. This approach may be called 'consensual', because it focuses on forming an agreement among experts and institutions rather than engaging in a debate with lobby groups and the general public. Recommendations aim to improve rather than replace the consensual expert-based model, through: a risk communication task force that will develop a strategy to deal with local planning matters; clarification of risk based and hazard-based approaches in a way that makes sense to non-experts; re-connecting research on societal risk with risk communication studies; taking a proactive role in explaining in lay terms the processes, roles, and responsibilities of the actors involved in complex governance processes; learning from risk communication techniques to develop proactive risk communication with the media, in sensitive areas where business as usual is no longer effective.

T4-I.3 Bourdon SE, Fong V, Caron JD; sean.bourdon@forces.gc.ca
Defence R&D Canada, Centre for Operational Research and Analysis

ASSESSING AND CONVEYING RISK IN A MILITARY CAPABILITY-BASED FRAMEWORK

Capability-based planning involves a solution-independent look at what capabilities provide the military the ability to best execute its missions. It facilitates the process of prioritizing items in the acquisition process and streamlining R&D activities to better align with military needs. This presentation proposes a risk assessment methodology based on the standard threat/vulnerability/consequence formulation of risk. For each capability gap, risk is illustrated on a "watermelon" chart using a triangular region whose vertices represent scenarios that maximize threat (most common), vulnerability (most dangerous), and consequence (most damaging), respectively. Subject matter experts (SME) provide order of magnitude estimates for threat, vulnerability, and consequence for each gap/scenario pair and establish thresholds that identify the significance of the computed risk values. The aggregate risk assessment is obtained by combining the individual assessments using fuzzy sets, which eliminates the need to achieve consensus among the SMEs and provides much needed flexibility in dealing with constantly shifting defence priorities. The presentation also introduces a few novel techniques for illustrating the benefit associated with the implementation of risk mitigation measures. All risk regions, not just the triangular ones advocated within this presentation, are easily converted into "risk density functions" (RDFs) that show the distribution of risk values within the risk region. As with probability density functions, each RDF has a corresponding cumulative distribution function (CDF). Both of these representations are helpful in assessing the benefit of any single capability solution that addresses an existing gap, or for comparing the relative merits of disparate capability solutions. The paper also shows how CDFs can be used to construct ordinal dominance curves, which provide an objective measure of the difference between a pair of risk regions.

T3-D.4 Bowles EA, Mokhtari A, Todd E, Lapinski M; ebowles@rti.org
North Carolina State University

AN INNOVATIVE AGENT-BASED MODEL FOR TRANSMISSION OF CONTAMINATION IN CHILDCARE CENTERS

According to the National Foundation of Infectious Diseases, children in out-of-home childcare centers (CCC) are at higher risk of infectious diseases compared to stay-at-home children. Of particular concern are intestinal tract infections, which are typically spread through exposure to contaminants (e.g., Norovirus, Shigella) in the feces and are transmitted via the fecal-oral route. While the transmission of these contaminants appears to occur primarily via hands, there is reasons to believe that the immediate environment (toilets, toys, diaper changing stations, etc.) as well as consumed foods may be contributing factors. Therefore, a risk assessment model

is needed to further understand the disease dynamics through a network of contacts between humans, the environment, and foods. In this study, we develop an agent-based quantitative predictive risk assessment model that simulates the spread of contamination and disease within a CCC based on individuals' interactions and behavior. Explicit modeling of spatial and temporal distributions of contamination was intended due to heterogeneity of contamination. The model is supported by a comprehensive relational database which provides scientifically-based information for model parameters based on literature data, observational data, and swap samples. The model serves as a "virtual laboratory" to characterize baseline risks and estimate potential reductions in risk that may be achieved through alternative mitigation strategies. The model's flexible design allows for unlimited adjustments of parameter values including sanitation compliance and efficacy, behavioral factors, and operational practices such that effective risk communication/intervention strategies can be developed. This work provides: (1) a mathematical framework for predicting the transmission dynamics of contaminants within a CCC; and (2) a practical tool to analyze proposed mitigations designed to reduce the risk of infectious diseases in a CCC.

P.102 Boyd AD, Einsiedel EF; adboyd@ucalgary.ca
University of Calgary

PUBLIC PERCEPTIONS OF CARBON CAPTURE AND STORAGE IN CANADA: RESULTS OF A NATIONAL SURVEY

Energy production is critical to the Canadian economy and lifestyle. Canada is not only the fifth largest energy producer in the world, it is also one of the highest per-capita consumers of energy. Fossil fuels currently supply the vast majority of Canadian energy needs and the result is high levels of greenhouse gas emissions. Concurrently reducing Canada's reliance on fossil fuel and its production of greenhouse gas emissions is a large challenge. Carbon dioxide capture and geological storage (CCS) is one potential strategy to reduce greenhouse gas emissions and has attracted much interest and support from both the Canadian government and industry. One of the most important factors in CCS implementation is public support and acceptance of the technology. These factors are far from understood. A survey was administered in July 2010 to examine public views on and understanding of key issues surrounding CCS. The survey was administered via Internet and phone to a representative sample of 1,479 Canadians recruited by a market research firm. Results indicate that 61% of Canadians reported little to no knowledge about CCS. The majority of respondents (84%) agreed that the government should require companies to reduce the amount of carbon dioxide that they emit but only three in ten maintain that CCS can help address the problem of climate change (31%). Trust in government to regulate technology and industry ability to develop CCS are also explored. We conclude by discussing strategies for raising awareness of CCS among the Canadian public and the policy challenges associated with the technology.

P.14B Brody T, Walts A, Bolka B, Knightly T, Delisio E, Maso C; brody.tom@epa.gov

US Environmental Protection Agency, Region 5, Chicago

TOOLS FOR SUPPORTING ENVIRONMENTAL JUSTICE DECISIONS

One of EPA Administrator Lisa Jackson's top priorities includes "working for environmental justice (EJ)." Challenges lie ahead in determining which communities need such attention. Who might be at risk? What are the burdens? To assess these situations, the Region 5 Office of the EPA is implementing a standard Environmental Justice (EJ) screening approach to identify "potential EJ areas of concern" and promote a more consistent understanding of potential EJ concerns. This approach will include indicators of potential disproportionate impact, population vulnerability, and address barriers to effective public participation. As a screening approach, it will be supplemented with additional information as needed to support action from the regulatory programs in the Region. Part of this screening approach includes the use of the Environmental Justice Strategic Enforcement Assessment Tool (EJ SEAT). EJ SEAT has helped the Region 5 consistently identify areas with potentially disproportionately high and adverse environmental and public health burdens. EJ SEAT uses 18 select federally-recognized or managed databases as the basis for the tool. Census tracts in each state are assigned an EJ SEAT score. The scores are determined by a simple mathematical algorithm using the scaled data of each database. Data within each indicator category are ranked, summed and averaged for each Census Tract in a state. EJ SEAT results are being integrated with multimedia facility information and monitoring data in a web mapping and analysis tool called EJAssist. EJAssist allows the user to select an area of interest and discover nearby features such as nearby EJ SEAT scores and demography. EJ screening and reporting has been greatly enhanced in the Region with all these tools and approaches. The views expressed are those of the authors and do not necessarily reflect the views or policies of the EPA and should not be construed as implying EPA consent or endorsement.

W1-B.1 Brown PD; philbrown@utah.gov

Utah Division of Wildlife Resources

OVERVIEW OF THE ECOLOGY AND PHYSICAL HABITAT OF THE GREAT SALT LAKE

The Great Salt Lake is a unique ecosystem that supports a surprisingly robust and diverse food web. The lake is the largest perennial salt lake in the western hemisphere and provides important habitat and forage for a large number of migratory bird species. Typical of saline lakes, the Great Salt Lake has a simple aquatic food web when compared to freshwater habitats, but research over the past decade has revealed greater complexity than previously understood. The aquatic food web and avian use of this resource will be discussed, and the highly variable physical environment and its effect on lake ecology will be explored. Mercury and selenium concen-

trations within primary and secondary producers obtained through a collaborative interagency effort will also be presented.

W1-E.3 Burch DF, Turley AT, Shapiro A, McVey MM; dburch@icfi.com

ICF International

EXPOSURE AND HUMAN HEALTH RISK MODELING OF MERCURY EMISSIONS AS PART OF EPA'S RISK TECHNOLOGY AND REVIEW (RTR) PROGRAM: A CASE STUDY

ICF is assisting U.S. EPA's Risk and Technology Review (RTR) program in evaluating human health risks associated with exposures to air toxics, including potential ingestion exposures to persistent and bioaccumulative hazardous air pollutants (PB-HAPs) that can accumulate in aquatic and agricultural food chains. In 2009, two case studies illustrating the risk assessment approach and methods used by EPA for RTR were presented to an expert panel of EPA's Science Advisory Board (SAB) for review and comment. A component of one of these case studies was a refined (i.e., post-screening) multipathway exposure and risk assessment of mercury emissions from a Portland cement manufacturing facility. In this presentation, we provide an overview of the methods and models employed to model human multipathway exposures and risks associated with mercury emissions for this particular case study (including the application of EPA's TRIM.FaTE model and an ingestion exposure and risk characterization model tailored for use in RTR), summarize the results of the assessment, and discuss how this approach corresponds to EPA's obligations with respect to RTR. We also discuss important lessons learned from this case study application and summarize technical feedback provided by the SAB expert panel as part of their review.

P.32 Burger J, Gochfeld M, Shukla S, Jeitner C, Pittfield T; burger@biology.rutgers.edu

Rutgers State University

RESOURCE USE AND VALUATION BY NATIVE AMERICANS AND OTHERS IN THE NORTHWESTERN UNITED STATES

There is considerable interest in how people use resources, how they value and evaluate resources, and how resource use varies by demographic factors, particularly ethnicity. Although it is assumed that Native Americans have higher natural resource use than other Americans, this is seldom examined, particularly in places where outdoor resource use might be high for everyone. These differences might be particularly critical for Department of Energy lands currently in the process of clean-up, and for which Tribes have treaty rights. We examined resource use and evaluation by Caucasian and Native Americans at an Indian event in Idaho, not far from the Hanford Site. We were particularly interested in how resource use varied, and whether evaluations reflected this resource use. Although a higher percentage of Native Americans reported consumptive uses and "religious" uses, the percent en-

gaged in non-consumptive uses was similar. There were significant differences in the rating of the different environmental features: 1) unpolluted water, no visible smog, clean air, and lack of radionuclides that present a health risk were rated the highest for both consumptive and non-consumptive activities, followed by unpolluted groundwater and "appears unspoiled", 2) human dimension factors were rated the lowest in importance both types of resource use, and 3) Native Americans rated every environmental feature higher than did Caucasians for both resource use activities. Native Americans, with higher average activity levels for most activities, rated environmental features higher than did others for both consumptive and non-consumptive activities. These data can be used by environmental managers to determine potential resource use, and potential risk from exposure to environmental contaminants, by Caucasians and Native Americans using natural or contaminated habitats. This research funded by CRESPP (DOE DE-FC01-06EW07053) and NIEHS (P30E5005022).

P.34 Burger J, Gochfeld M, Powers C; burger@biology.rutgers.edu

Rutgers State University

RESOURCES, RESTORATION, AND ATTITUDES TOWARD NATURAL RESOURCE DAMAGE ASSESSMENT

One of the largest environmental problems in the USA is remediation, restoration, and management of contaminated lands, including Natural Resource Damage Assessment (NRDA). A key aspect is to understand public concerns and perceptions about resources, injuries, and remediation/restoration. We interviewed 401 subjects at a Native American Pow Wow in Northwestern Idaho, not far from the Department of Energy's Hanford Site, to examine their perceptions about 1) the meaning of NRDA, 2) the agencies that should restore resources if they are destroyed, and 3) the resources that should be restored. Subjects were mainly Native American and Caucasians. Fewer than 5% knew about NRDA, although over 95% felt that any damaged resources should be restored. There were significant differences between Native Americans and Caucasians in their perceptions of who should restore resources, ratings for the importance of particular agencies to restore resources, ratings of the importance to restore specific resources, and in the importance of the government's engagement in other habitat and resource restoration. In general, 1) Native Americans felt that "everyone" should be involved in restoring damaged resources, while Caucasians favored governmental intervention, 2) Native Americans rated the responsibility for restoring resources higher for every organization or agency than did Caucasians, 3) Native Americans rated it more important to restore every group of species (and cultural sites) than did Caucasians, and 4) Native Americans rated environmental actions that protected ecosystems higher than did Caucasians, but Caucasians rated human dimensions (adding more signs, police and boardwalks) more important than did Native Americans. The three resources thought to be most important to restore, to Native Americans were tribal sacred ground, endangered

wildlife and plants, and cultural sites, while Caucasians listed endangered wildlife and plants, and fish. This research was funded by CRESP (DOE DE-FC01-06EW07053) and NIEHS (P30E5005022).

W1-I.3 Burns WJ, Slovic P, Peters E; bburns@csusm.edu

Decision Research

EXAMINING PUBLIC RESPONSE TO NATURAL DISASTERS AND TERRORISM: THE ROLE OF SYSTEMS AND LONGITUDINAL MODELING

Respondents nationwide participated in a longitudinal study following the Christmas Day terrorist attempt. Five surveys were conducted that tracked public response not only to this event but to the earthquake in Haiti, the terrorist attempt in Times Square and the oil spill in the Gulf. Perceptions of risk, emotional reactions and behavioral intentions with regards to these events were analyzed and compared. A latent growth curve model was constructed to analyze the trajectory of perceived risk over these five time periods. A system dynamics model is also proposed to discuss important feedback processes that may underlie response to crises like these.

P109 Butler KM; kbutler@mclam.com

McDaniel Lambert, Inc.

QUALITATIVE VS. QUANTITATIVE DATA QUALITY OBJECTIVES: WHAT SHOULD REASONABLE PEOPLE WHO ARE NOT STATISTICIANS DO?

Traditionally the USEPA's recommended approach to the data quality objectives process includes statistical justification for sampling design. However in practice, data collection as part of the risk assessment process is often conducted based on experience and best professional judgment in order to collect representative data with adequate reporting limits. Using a case study of a human health risk assessment for a 95-acre site on the California central coast, the effectiveness of both quantitative and qualitative approaches to data quality objectives are discussed. In this case study, several qualitative measures were taken to ensure that data collection met risk assessment goals: (1) qualitative data quality objective statements to guide soil and soil gas sampling efforts, (2) a formal data usability analysis that included spatial representation of the data, and (3) a qualitative data quality assessment to validate sampling objectives. In addition to the qualitative steps taken, a quantitative data quality assessment was conducted retrospectively to verify that sufficient data were collected through statistical sample size calculations. Ultimately, both qualitative and quantitative approaches strive to answer the same question: are there adequate data to make defensible risk management decisions? The benefits and limitations of each approach and the application to risk assessment are reviewed.

P108 Cabrera V; victor.cabrera@udp.cl

Universidad Diego Portales

STENOSIS.....A RISK THAT CAN BE AVOIDED?

Vascular pathologies such as cardiovascular and carotid stenosis are diseases that can be chronic, expensive, and many times a mortal disease. In spite of the aforementioned this disease can be avoidable. In most developed countries as well countries under developing conditions, stenosis is the second mortality cause. In fact, in many countries is the main mortality cause. About 1.5 to 2% of fatalities are due to stenosis, all over the world. This pathology is due to a narrowing of the internal carotid artery sited in the face plane. Because this narrowing, the artery changes its physical properties provoking a thickness and elasticity loss of the artery wall. Therefore, is very important to know and understand this artery because is the fresh blood transport via to the upper plane and into the brain. When this artery is blocked stenosis, is the result, because blood flowrate is very poor, besides clots, embolus and thrombosis can be expected. Standardized studies to treat this disease are found in NASCET, ACAS and ESCT. These studies developed empirical relationships in symptomatic and no-symptomatic patients, giving information about the situation of the patient, taking into account stenosis percentage. According to results found in patients, is the treatment ought to be finally followed. The treatment can be medications, angioplasty stent or carotid endarterectomy. To study this disease following a physical and engineering method is the most important investigation, because blood and arteries can be study under its properties and blood flowrate, analyzing its behavior in these conduits due to velocity and viscosity, therefore Reynolds Number can be found. Once this number is found, some conclusive discussions will help to diagnose the final treatment.

M2-C.1 Cacciatore MA, Brigham Schmuhl N, Binder AR, Scheufele DA, Shaw BR; mike.a.cacciatore@gmail.com

University of Wisconsin-Madison

ASSESSING PUBLIC OPINION OF ALTERNATIVE ENERGIES: THE ROLE OF COGNITIVE ASSOCIATIONS IN SUPPORT FOR BIOFUELS

Public opinion research has demonstrated that evaluations of risks are conditional on the cognitive information or mental associations that are most accessible to individuals at the time of decision-making. This study examines such associations relative to biofuels (e.g., the extent to which people associate biofuels primarily with ethanol, corn, etc.), and how these associations influence societal-level support for this alternative energy technology. To investigate these relationships we conducted an RDD telephone survey of 600 residents of a top biofuels-producing region of the United States in 2009. Prior to reporting overall opinions of the technology, respondents were asked to indicate the first thing that came to mind when they thought about biofuels. Respondents were then randomly assigned to an experimental condi-

tion emphasizing either “ethanol” (a popular biofuel commonly blended into gasoline), or the umbrella term “biofuels” (indicating any fuel made from plants or organic materials) when asking for their overall attitude. Our analyses revealed that individuals who associated biofuels with food sources (including corn) or ethanol were less likely to support ethanol and biofuels under a variety of circumstances. The results showed that while main levels of support did not differ based on whether respondents were asked about “ethanol” or “biofuels,” there was a significant interaction between those associating biofuels with corn and our experimental manipulation. When respondents were asked their degree of support for ethanol, those with an initial “corn” association were significantly less likely to support ethanol even if it was believed to benefit farmers. However, when respondents were asked about support for the more general biofuels, there were no discernible differences between those with or without this initial association to corn. The implications of these findings are discussed in terms of context effects on judgments of societal risk.

W2-H.2 Cacciatore MA, Brigham Schmuhl N, Binder AR, Scheufele DA, Shaw BR; mike.a.cacciatore@gmail.com

University of Wisconsin-Madison

OFF THE TOP OF YOUR HEAD: EXPLORING THE INFLUENCE OF MENTAL ASSOCIATIONS ON RISK AND BENEFIT PERCEPTIONS OF BIOFUELS

Recent investments and government mandates have positioned biofuels to become a major renewable energy source to help replace the largely fossil fuel-based energy economy of the United States. However, while research has demonstrated that risk and benefit perceptions can have profound influences on the acceptance or rejection of scientific innovation, little is known of how the public perceive of the risks and benefits of biofuels. Moreover, because “biofuels” is an umbrella term incorporating any type of fuel produced from organic matter, understanding exactly how citizens think of biofuels is important for our understanding of public opinion of the fuel source. This study seeks to provide such an understanding by exploring the influence of the mental associations a survey respondent has with biofuels on psychological evaluations of the economic, environmental, political, and social/ethical risks and benefits of the energy source. In order to investigate these influences, we rely on data from an RDD telephone survey of 600 residents of a top biofuels-producing U.S. state (conducted April to June 2009). Prior to assessing risk and benefit perception across these four domains of interest, respondents were asked via a single open-ended question to indicate the first thing that came to mind when they thought about biofuels. We then coded these responses into several “association” areas. The results revealed that those respondents who indicated associating biofuels with either of corn, food issues, or ethanol had less positive benefit vs. risk perceptions of the energy source. In short, those with the above mental associations tended to perceive

fewer economic, social/ethical, and political benefits than risks as compared to respondents who did not have this association to corn, food issues, or ethanol. The implications of these findings are discussed in terms of variability in individual risk perceptions and the processes influencing this variability.

P.14 Camp JS, Abkowitz MD; janey.camp@vanderbilt.edu
Vanderbilt University

A NEW APPROACH TO ENTERPRISE RISK MANAGEMENT: METHODOLOGY DEVELOPMENT AND PILOT APPLICATION

While the concept of risk management has permeated through most organizations today, a significant challenge remains in applying risk management methods and practices across the entire enterprise. Some of the obstacles to implementing an effective enterprise risk management (ERM) program stem from institutional and cultural differences within an organization, but much of the problem lies in the lack of a holistic and systematic process for employing an ERM protocol. Presently, risk management decision-support tools tend to be either myopic in nature, focused on a sub-set of enterprise risks (e.g., financial, employee health and safety, environmental), or they provide an abstract ERM framework without sufficient guidance on how to define and evaluate hazards and events. This paper describes the development of an ERM methodology designed to overcome the limitations of current ERM methodologies. It begins with the definition of a comprehensive classification of hazards that may threaten an organization, from which a full spectrum of representative event scenarios can be constructed. These scenarios are then subjected to “risk scoring”, utilizing likelihood and consequence ratings that cover the entire range of potential outcomes. Once compiled, these ratings are positioned on a risk heat map, such that risk evaluations can be performed at the scenario, hazard and enterprise level. The paper concludes with a description of the results of a pilot study in which the ERM methodology has been applied to a large transport carrier.

W3-I.3 Campbell V, Arvai J; campb575@msu.edu
Michigan State University

REVIVING “THINK GLOBALLY, ACT LOCALLY”: THE PROMISE OF ASYMMETRIC PATERNALISM FOR MANAGING THE RISKS OF GLOBAL CHANGE

The notion that people may “think globally and act locally” has tremendous theoretical and practical appeal when we consider the multitude of environmental risks that must be confronted the world over. Some 40 years after the concept of “think globally, act locally” was introduced, studies suggest that people are becoming increasingly concerned about the health of the natural environment. But, research also shows that most people still fail to make even rudimentary changes - i.e., those that result in little or no negative effect on individual or household well-being - in their behavior aimed at addressing the environmental consequences of their actions.

For this reason, finding ways to encourage individual behavior change on a meaningful level has been the emphasis of risk and environmental education efforts going back decades. Unfortunately, work in the decision sciences has generally shown that the provision of information alone, via environmental education or risk communication efforts, to aid or enhance individual decision-making is often of limited utility. Behaviors tend to be resistant to information provision unless accompanied by a disruption of the cues that may be triggering them. Related, choices are often made from among the alternatives present at the time of the decision, or by satisfying immediate and emotionally powerful desires at the expense of longer-term needs. However, recent work on asymmetric paternalism has shown that it may be possible to revive “think globally, act locally” by re-engineering the environment in which many simple, but consequential choices are made. In this presentation, we outline three experiments we conducted to test the effectiveness of asymmetric paternalism in terms of its ability to facilitate choices that help to reduce environmental risks by encouraging people to think globally, act locally.

T2-B.1 Canady R; rcanady@ilsa.org

Center for Human Health Risk Assessment, IL SI RF

APPROACHES TO NANO STUDY COMPARABILITY: CHALLENGES AND ACTIONS.

The current approach to evaluating the risks of a chemical involves drawing information from a variety of sources and across multiple domains of evaluation; however, an analogous approach for many nanomaterials faces unaddressed challenges. For example we draw information about genetic toxicity largely from in vitro studies, about neurotoxicology from animal studies, persistence from partition coefficients, exposure from monitoring environmental media, and so on. Knowing that for example benzene is being tested in cell culture, in drinking water to rats, or monitored in air is a routine matter of chemical analysis. Furthermore, to evaluate studies across different laboratories it is a simple matter to know that benzene of certain purity was used. For a nanomaterial it is not clear that studies across laboratories can be combined. This is partly due to variability in reporting of the characteristics of the material, but also partly due to issues such as variation in dispersion methods, and variation across manufacturing processes and batches. This variation presents a formidable challenge, particularly when considering that the causes for variation in biological response are themselves being explored through the studies. Furthermore, the relationship between the nanomaterial studied in a laboratory setting and the nanomaterial in an environmental setting is in many cases likely to be unknown. In other words, in many cases it is likely that we are not entirely sure what the important aspects of toxicity are, and we are not sure that they are being captured or reported in studies in the literature, so creating traditional risk summaries across multiple sources of data is an unmet challenge. In the converse, using single studies to extrapolate to

risks for classes of nanomaterials is also infeasible for largely the same reasons. This presentation will explore the efforts to describe and address this challenge of “comparability” to the risk analysis of nanomaterials.

M4-H.3 Canis L, Seager T, Keisler J, Linkov I; igor.linkov@usace.army.mil

US Army Engineer Research and Development Center

SELECTING NANOMANUFACTURING TECHNOLOGY: VALUE OF INFORMATION ANALYSIS

The unprecedented variability and uncertainty associated with engineered nanomaterials amplifies green nanomanufacturing needs: potential hazard and exposure, environmental fate and transport, dose-response relationships, and life-cycle environmental consequences must be evaluated and inform selection of manufacturing technology which minimizes the overall life-cycle risk and maximize industrial benefits. This paper presents a decision-analytic framework that integrates risk assessment and life-cycle assessment tools for nanomaterial manufacturing that synthesizes both the objective scientific information which drives analysis along with subjective and values-driven information that drives deliberation. As an illustrative example, this framework is applied to the problem of single-wall carbon nanotubes (SWCNT). Four different synthesis processes (arc, chemical vapor deposition, high pressure carbon monoxide, and laser vaporization) are compared relative to five salient decision criteria (energy consumption, material yield, life-cycle environmental impact of bulk chemical releases, cost, and toxicological properties of the tubes themselves). Performance assessments are modeled stochastically as beta distributions, or on a “high-medium-low” ordinal scale. A probabilistic rank ordering of preferred process pathways is determined using outranking normalization and linear-weights aggregation in several different weighting scenarios: completely unknown weights (i.e., stochastic sampling of all weight combinations), and four fixed-weight scenarios representing hypothetical stakeholder views. Value of Information Analysis (VoI) is conducted to assess the utility of acquiring additional information on manufacturing processes and the life-cycle risk of products. The results show that the decision is robust for most of the stakeholders, and acquiring new information has only a marginal utility for the nanomanufacturing alternative selection in this case.

T4-E.4 Cao Y, Liu X, Frey HC; frey@ncsu.edu

North Carolina State University

MODELING AND EVALUATION OF IN-VEHICLE EXPOSURES TO FINE PARTICULATE MATTER FROM AMBIENT POLLUTION AND SMOKING

Penetration of ambient particles and environmental tobacco smoke (ETS) are significant contributors to in-vehicle human exposure to fine particulate matter of 2.5 microns or smaller (PM_{2.5}). The concentration of ambient fine particles in a vehicle cabin depends on factors including area-wide ambient concentrations, incre-

mental contributions to ambient concentration from emissions of other vehicles operating on the same roadway, the degree to which windows are open, the mode of usage of the heating, ventilating, and air conditioning (HVAC) system, filtration and deposition inside the vehicle, and vehicle cabin interior volume. Survey data from the literature indicate that a significant portion of in-vehicle exposure to ETS is to non-smokers who are traveling with a smoker. A critical assessment was conducted of a mass balance model for estimating PM_{2.5} concentration with smoking in a motor vehicle. Sensitivity analysis was used to determine which inputs should be prioritized for data collection. The number of cigarettes smoked per hour, and cigarette emission rate lead to linear variation in estimated PM_{2.5} concentration. Air exchange rate (ACH) and deposition rate lead to large variation in exposure. The in-vehicle ETS mass balance model was applied to simulation output from the Stochastic Human Exposure and Dose Simulation for Particulate Matter (SHEDS-PM) model to quantify the potential magnitude and variability of in-vehicle exposures to ambient PM_{2.5} and to ETS. Factors that reduce in-vehicle exposure to ETS, such as opening windows, increase exposure to ambient PM_{2.5}, and factors that reduce exposure to ambient PM_{2.5}, such as closing windows and running the HVAC system in recirculation mode, can increase exposure to ETS. Results indicate that in-vehicle exposure can be a significant contributor to total daily average exposure.

P.71 Cao Y, McGill W; yuc169@ist.psu.edu
College of Information Sciences and Technology, PSU

MAXIMIZING PURPOSIVE GAIN IN A SERIOUS GAMING CONTEXT

A serious game has a primary purpose other than entertaining the players, which in general can be described as the transmission of information between the game operators and the game players. Thus the amount of new information transmitted in a gameplay process can to some extent measure the performance of a serious game. We propose the concept of purposive gain to represent the extent to which the primary purpose of a serious game is achieved during the gameplay process among targeted groups of players. In a serious game design, the maximization of the purposive gain should hold as one of the primary objectives. We take the LinkIt game as an example and study different approaches in order to maximize the purposive gain. The scientific objective of the LinkIT game is to collect data on how different individuals understand the causal relationships between hazards in different situational contexts. That is, the LinkIT game focuses on eliciting risk perceptions of the players. The purposive gain of LinkIT is a function of both the quantity and the quality of the obtained data from gameplay. In particular, we define mathematical metrics to measure the purposive gain and study alternative intelligent game puzzle selection strategies in order to maximize the purposive gain. The study considers players' skill levels, play credibility modes, and cultural effects. A discussion on other factors that influence gain (e.g., player enjoyment) concludes this presentation.

P.3 Cardenas CA, Lizarazo JJ, Muñoz F; ca.cardenas6@uniandes.edu.co
Andes University

FUELS TRANSPORTATION NETWORK DESIGN: MINIMIZATION OF RISK ASSOCIATED TO HAZARDOUS MATERIALS TRANSPORTATION

Transportation network design for hazardous materials has been an important concern for all the actors involved in the production chain. The cost associated in the material transportation is the central concern for producers, looking for the best route design in order to minimize the logistics costs. In contrast, government policies are not interested in the transportation costs, it concerns are related to the risk of hazardous materials transportation. According to these different aims, transportation network designs have been proposed seeking to satisfy both parts in the production chain. Focusing in diesel and gasoline as the hazardous materials to be transported and trying to include both goals of minimizing cost and chemical risk in a one level model, a linear optimization program are proposed for the transportation network in Bogotá, Colombia. For the optimization model, the risk of each path calculated includes the infrastructure risk related to the stock of basic facilities and capital equipment across path, the environmental risk associated to the external conditions in the path and the population risk associated to the people that should be in the path. Once the linear model show it results, suggestions about the actual distribution model and new alternatives could be done to establish the best alternative for Bogota.

W2-F.3 Chakraborty S; sweta.chakraborty@gmail.com
Kings College London

PUBLIC PERCEPTIONS OF INCREASED POST-AUTHORIZATION VIGILANCE TOWARDS PHARMACEUTICAL SECTOR SUSTAINABILITY

There has been a notable observed trend towards the strengthening of pharmacovigilance systems for medicines as part of ex-post regulation leading to enhanced post-authorization vigilance (Hodges, 2005). For the pharmaceutical industry, the opportunities for economic sustainability are evident. Particularly, the potential for switching from reliance solely on costly pre-authorisation testing of medicines towards postponing completing development post-authorisation as part of lifecycle product management should yield considerable savings by allowing revenues on a marketed product (Hodges, 2008). However, to enable this model requires reinforced post-authorisation pharmacovigilance. While the benefits of this change for the industry may be apparent, several technical and ethical challenges are simultaneously realized. In particular, two questions arise: firstly, how much do we know about the lay value-based implications associated with earlier drug approvals, such as trust in the regulatory system, so that the public will not feel more vulnerable to the occurrence of adverse drug reactions than prior to such a shift in policy? Sec-

ondly, how should we hypothesize the social contract desired by patients in regards to the logistics of increased pharmacovigilance, primarily in regards to whom or what would be held accountable for any related adverse outcomes? We can start answering both these questions by drawing upon existing empirical evidence from similar past case studies in the field of risk perception (Slovic, 1993; Lofstedt, 2005) and by extrapolating from ongoing risk perception research on public attitudes towards the pharmaceutical industry and its regulators in relation to the role of trust in chronic prescription drug-taking. Pooling of such evidence will allow for predictions on how the public might receive earlier approvals through the use of an evidence-based perspective (Chakraborty, 2010).

M2-G.3 Chan SH, Cousins AC, Domesle AR, Jones KL, Kissel JC, Meschke JS; jkissel@u.washington.edu

University of Washington

RISK OF STILLBIRTH DUE TO MATERNAL CONSUMPTION OF LISTERIA MONOCYTOGENES-CONTAMINATED FRESH SOFT CHEESE IN HISPANIC PREGNANT WOMEN

Background: *Listeria monocytogenes* has become a successful foodborne pathogen because of its inherent ability to survive various food processing technologies that rely on acidity and salts, and it can multiply at low temperatures associated with household refrigerators. The prevalence of *L. monocytogenes* in dairy products varies widely. Dairy food safety, specifically Mexican-style fresh soft cheeses such as queso blanco, panela, and queso fresco, has been the focus regulatory agencies in response to outbreaks worldwide. Pregnant women are at increased risk of listeriosis, the infection caused by *L. monocytogenes*, and the bacteria can cross the placenta to the fetus leading to premature delivery, prenatal sepsis, and stillbirth. Methods: Using quantitative microbial risk assessment, the risk of stillbirth associated with a typical day's maternal consumption of *L. monocytogenes*—contaminated fresh soft cheese was estimated. The exposure assessment included analysis of cheese-contamination levels, bacterial growth rate models accounting for post-retail storage, serving size, and servings consumed per day. Logistic, Beta-Poisson, and exponential dose-response models were developed using data from pregnant nonhuman primates and guinea pigs, both exposed orally and followed for adverse fetal outcomes. A two-dimensional Monte Carlo analysis was used to predict the probability of stillbirth from consumption of contaminated fresh soft cheese. Results: Consuming contaminated fresh soft cheese results in an estimated median dose of 1.32×10^7 colony forming units of *L. monocytogenes*. Based on a logistic dose-response model of the pregnant guinea pig and nonhuman primate data, the two-dimensional Monte Carlo analysis predicted a median probability of stillbirth at 0.42 for median-volume cheese consumption. Conclusions: Fresh soft cheese contaminated with *L. monocytogenes* poses a serious risk to fetal health, especially in Hispanic pregnant women. The high

probability of stillbirth suggests that consumption of contaminated cheese can have very serious consequences.

P.110 Chang EJ, Park SH, Jeong JS, Joo IS, Yoon HS, Sohn YW; ceuujung@kfda.go.kr

Korea Food and Drug Administration

MONITORING OF LEAD AND CADMIUM IN AGRICULTURAL PRODUCTS COLLECTED FROM THE KOREAN MARKET

Lead(Pb) and Cadmium(Cd) are the most abundant heavy metals in our environment. The excessive content of these metals in food is associated with etiology of a number of disease, especially with cardiovascular, kidney, nervous as well as bone diseases. In this study, we investigated the levels of Pb and Cd in 8 items of agricultural products collected in Korea to establish Korean standards of Pb and Cd. The 476 samples of barley, beans(mung bean, kidney bean and green bean) and fruits(pineapple, apricot, Japanese apricot and plum) including domestic and imported products were collected from local markets. The concentrations of Pb and Cd were measured using ICP-MS after microwave digestion with HNO₃ and H₂O₂. The limits of quantification were 0.2 and 0.1ug/kg for Pb and Cd, respectively. The recovery rates in fortified samples were 84.2~103.9% for Pb and 83.5~105.2% for Cd. The levels of Pb ranged from 5.6 to 52.5ug/kg in barley, 1.3 to 33.4ug/kg in beans and N.D.(not detected) to 54.2ug/kg in fruits. The levels of Cd ranged from 4.0 to 37.7ug/kg in barley, 0.3 to 20.6ug/kg in beans and N.D. to 14.0ug/kg in fruits. The levels of Pb and Cd in 8 items of agricultural products were considerably low compared with the current EU and Codex standards(Pb 200ug/kg and Cd 100ug/kg in barley and beans, Pb 100ug/kg and Cd 50ug/kg in fruits). These monitoring results will be utilized as important data for the establishment of Korean standards of Pb and Cd in 8 items of agricultural products.

T4-I.2 Checknita D; dean.checknita@hq.dhs.gov

Department of Homeland Security - Homeland Infrastructure Threat and Analysis Center

A DISCIPLINED APPROACH TO BUILDING RISK ANALYSIS CAPABILITY

In order to assure that the DHS National Infrastructure Protection Partnership is able to perform critical infrastructure and resiliency risk analysis across the wide spectrum of homeland security threats and hazards the Office of Infrastructure Protection performed a Capability Based Assessment. Capability Based Planning is used at the White House across preparedness frameworks and ensures the nation's capability to manage risk given the uncertainty that exists in the world today. The Homeland Infrastructure Threat and Risk Analysis Center will present implementation of Capability Based Planning and Assessment specific to risk analysis.

T3-I.1 Cheesebrough T, Bennett SP; tony.cheesebrough@hq.dhs.gov

Department of Homeland Security, Office of Risk Management and Analysis

TO BE OR NOT TO BE: WEIGHING ERRORS OF OMISSION AND COMMISSION IN DECISION SUPPORT FOR HOMELAND SECURITY RESOURCE ALLOCATION THROUGH ALL-HAZARDS RISK ASSESSMENT

The Department of Homeland Security spends nearly \$60 billion each year on activities ranging from screening people, baggage, and cargo at air, land and sea ports; patrolling the borders and coastline; protecting critical infrastructure and key resources; and preparing for, responding to, and assisting with the recovery from disasters. Risk analysis is one source of information among many (e.g., Administration and Secretarial priorities, legislative requirements, and others) that can help to prioritize this wide range of missions and security activities. By estimating the likelihood and consequences of specific events, risk assessments can provide a consistent means for comparing the many risks our nation faces, including those from terrorism, natural disasters, and transnational crime. However, it has been suggested that the risks of terrorism and natural disasters cannot be combined in one meaningful indicator of risk and that an all-hazards risk assessment is not practical. Such criticism contends that DHS should not yet attempt an all-hazards risk assessment because of the heterogeneity and complexity of the risks within its mission, and instead suggests qualitative comparisons to illuminate discussion of risks as decision support. Nonetheless, in recent years, the President and Congress have required federal agencies with homeland security responsibilities to apply risk management to inform decisions regarding resource allocation and prioritizing security activities. Current DHS efforts to meet these requirements, such as the Risk Assessment Process for Informed Decision-Making (RAPID), demonstrate that all-hazards homeland security risk assessment is practical, and that characterizing uncertainty in the quantitative estimation of metrics like annualized expected fatalities and annualized expected economic loss is superior to qualitative comparisons in informing DHS leadership for making strategic planning, prioritization, and resource allocation decisions.

W2-G.1 Chen C-C, Wang I-J, Wu K.-Y; kuenyuhwu@ntu.edu.tw

National Taiwan University

A BAYESIAN MARKOV CHAIN MONTE CARLO SIMULATION PROCEDURE FOR RISK ASSESSMENT BY USING HUMAN DATA

Although the outbreak of children with nephrolithiasis due to melamine-contaminated infant formula in 2008 has subsided recently, it remains uncertain whether the present tolerable daily intake (TDI) of melamine provides sufficient protection to young children. To conduct a safety assessment for melamine in infant formula, we attempted to establish the dose-response relationship based on 12 nephrolithiasis cases among a total of 932 children aged 0 to 5 years with potential exposure to

tainted milk in Taiwan. According to the children's exposure history, distributions of individual daily melamine intake (mg/kg bw/d) were reconstructed using Monte Carlo simulations to account for uncertainties in exposure duration and melamine concentrations in tainted milk. Based on the reconstructed individual average daily intake (ADI) of melamine, subjects were further classified into four separate ADI groups: high, medium, low, and the reference group. A statistical logistic model was then fitted for the dose-response relationship between nephrolithiasis incidence and melamine daily intake using Markov chain Monte Carlo (MCMC) simulations. Different scenarios of additional risk of nephrolithiasis corresponding to melamine content in infant formula were assessed. The lower bounds of the 95% CIs of daily melamine intake of the additional risks of 1.0×10^{-4} , 1.0×10^{-5} , and 1.0×10^{-6} were 0.0030, 3.0×10^{-4} , and 3.0×10^{-5} mg/kg bw/d, respectively. In order to fully protect young children, the current melamine TDI level of 0.2 mg/kg bw/d recommended by WHO should be lowered based on the results.

M3-D.3 Chen Y; ychen@gmaonline.org

Grocery Manufacturers Association

PRACTICAL APPROACHES TO ADDRESS SALMONELLA IN LOW MOISTURE FOODS AND A NEED FOR QUANTIFYING THE RISK

Salmonella contamination of low moisture foods has re-emerged as a significant food safety problem. Two extensive outbreaks of Salmonella Tennessee and Typhimurium infections, each involved more than 600 cases across more than 40 states, were traced to peanut-derived ingredients in 2006-2007 and 2008-2009, respectively. In April 2009, millions of pounds of pistachios were recalled because of concerns of Salmonella contamination. On a global level, a number of outbreaks and recalls associated with low moisture products have been documented in the last several decades, which illustrate the wide diversity of low moisture products that can be contaminated with Salmonella and cause illness and underscore the difficulty in risk mitigation. The food industry in an effort to minimize the risk of Salmonella has developed a guidance document for Salmonella control when manufacturing low moisture foods. This presentation will review current industry best practices in the guidance that are based on hazard analysis and practical control measures through a review and synthesis of industry programs and the literature. Conducting surveys of Salmonella in widely used raw ingredients, in combination with using such data to conduct risk assessments, would generate further scientific support for the appropriate log reduction, and facilitate the determination and evaluation of effective control measures and risk mitigation strategies. This presentation will discuss the need for further efforts in understanding and quantifying risk, in order to enable industry to more efficiently and effectively reduce the risk of Salmonella contamination in low-moisture products.

P.78 Choi CW, Jeong JY, Hwang MS, Jung KK, Lee HM, Lee KH; cwchoi80@korea.kr

National Institute of Food and Drug Safety Evaluation

ESTABLISHMENT OF THE KOREAN TOLERABLE DAILY INTAKE OF BISPHENOL A BASED ON RISK ASSESSMENTS BY AN EXPERT COMMITTEE

Recently, reproductive and neurobehavioral effects of bisphenol A (BPA) have been documented, and thus a review was requested for BPA management direction by the government. Therefore, this study was performed to establish a Korean tolerable daily intake (TDI) for BPA. An expert committee, consisting of specialists in fields such as toxicology, medicine, pharmacology, and statistics, was asked to evaluate BPA health based guidance values (HbGVs). Although many toxicological studies were reviewed to select a point of departure (POD) for TDI, rat and mouse reproductive studies by Tyl et al. (2002, 2006), which were performed according to GLP standards and OECD guidelines, were selected. This POD was the lowest value determined from the most sensitive toxicological test. The POD, a NOAEL of 5 mg/kg bw/day, was selected based on its systemic toxicity as critical effects. An uncertainty factor of 100 including interspecies and intraspecies differences was applied to calculate the TDI. According to the evaluation results, a Korean BPA TDI of 0.05 mg/kg bw/day was suggested. In addition, the BPA exposure level based on food consumption by the Korean population was estimated as 1.509 ug/kg bw/day, and the HI was 0.03 when the TDI of 0.05 mg/kg bw/day was applied. This HI value of 0.03 indicated that hazardous effects would not be expected from BPA oral exposures. Although highly uncertain, further studies on low dose neurobehavioral effects of BPA should be performed. In addition, it is recommended that the 'as low as reasonably achievable' (ALARA) principle be applied for BPA exposure from food packaging materials in newborn infants and children.

P.38 Cifuentes LA, De la Maza C, Donoso FJ, Flores V, Hernandez MJ; fdonoso@conama.cl

Faculty of Engineering, Universidad Catolica de Chile

OPTIMIZING THE NET SOCIAL BENEFITS FOR EMISSION STANDARDS IN CHILEAN THERMOELECTRICAL PLANTS

In Chile, the main component of the energetic matrix is thermoelectric energy, which reached up to 60% of the installed capacity in 2009. Pollution emissions associated with this kind of technology leads to an increase in atmospheric contamination, and consequently to a significant social damage. No mandatory regulations regarding emission standards for thermoelectric plants exist in Chile. We present a cost-benefit analysis to establish the emission level for different types of Chilean energy plant for the 2010-2020 period. Our approach intends to maximize the net social benefit, including improvements in health and agriculture, but also abatement

equipment costs. We evaluated the net social benefit obtained applying several limits of emissions for Particulated Material (PM), SO₂ and NO_x, and concluded in a proposal that obtained the best net social benefit. We later compared it with the World Bank and European Union emission standards. Using a gaussian model, we made an estimation of the marginal damage that each emitted ton of the analyzed pollutants produce, using 2009 US dollars, for every Chilean thermoelectrical plant. The mean marginal damages were US\$ 1900, 13000 and 213 for PM, SO₂ and NO_x, respectively. For NO_x and PM the obtained values were lower than those from previous reports, while for SO₂ they were higher. The net social benefit present value obtained with our proposal was US\$ 370 million in an optimized regulated scenario, US\$ 100 million higher than WB regulation. However, when compared to the EU regulation, it reached US\$ 700 million more, which can be explained because the EU standards produced a negative net benefit.

M4-G.1 Clewell HJ; hclewell@thehamner.org

The Hamner Institutes for Health Sciences

CHARACTERIZATION OF POPULATION DISTRIBUTIONS FOR PBPK MODEL PARAMETERS

One of the more challenging issues that must be considered in performing a human health risk assessment is the heterogeneity among humans. This heterogeneity is produced by inter-individual variations in physiology, biochemistry, and molecular biology, reflecting both genetic and environmental factors, and results in differences among individuals in the biologically effective tissue dose associated with a given environmental exposure (pharmacokinetics) as well as in the response to a given tissue dose (pharmacodynamics). Population analysis is increasingly being performed with PBPK modeling, through Bayesian statistical analysis and Monte-Carlo sampling of parameters, to evaluate the impact of pharmacokinetic variability on individual risks. In particular, hierarchical Bayesian analysis can provide estimates of both population variability and uncertainty in parameters, although the outcome depends to some extent on the assumed initial (prior) distributions, and can only represent what is known from the study population analyzed, rather than the population as a whole. This talk discusses appropriate choices of parameter distributions such that the full population variability and uncertainty can be captured as well as considerations on how probabilistic modeling results can be integrated into current risk assessment practice.

T2-A.2 Cole BL; blcole@ucla.edu

University of California, Los Angeles School of Public Health

DIVERGENCE AND CONVERGENCE IN THE EVOLUTION OF HIA PRACTICE IN THE U.S.

Health Impact Assessment (HIA) in the U.S. has gone from one or two HIAs to an estimated sixty completed HIAs today with nearly half of these completed within the last two years. Many more HIAs are in progress. A convening of HIA

practitioners in North America had twenty participants in 2009; a second convening a year later attracted three times that number. As the numbers of HIAs has increased, the range of topics, methods and formats has become increasingly varied. Unlike environmental impact assessment (EIA), there is no national mandate for HIA. Only one state (Washington) has passed legislation in support of HIAs, and that legislation does not include any mandate or guidance for the content or methods for HIA. In the absence of clear mandates, HIA practice is evolving to fill diverse needs with varied objectives, functions and constituencies. The boundaries of what constitutes HIA are increasingly vague. At the same time, some HIA practitioners and agency officials are seeking more convergence in HIA practice. Multiple efforts are on-going to develop HIA standards that would help legitimize the role of HIA in policy-making and lay the foundation for a cohesive community of practice. In various state legislatures and Congress bills calling for greater use of HIA are being drafted. With or without such legislation, substantial questions remain about how HIA will meet the needs of stakeholders currently engaged in HIAs and how it will interface with EIA practice that has overlapping but not identical aims and areas of focus. After offering an analysis of the range of HIA practice this session will examine the pros and cons of possible legislation to support HIA both integrated into and separate from EIA.

M4-D.2 Cole D, Ayers T, Herman K, Hoekstra R; dcole@cdc.gov
Centers for Disease Control and Prevention

HOW MUCH IS IN A RECIPE? FOOD COMMODITY ATTRIBUTION OF OUTBREAK-RELATED ILLNESSES USING TWO SCHEMES FOR CATEGORIZING COMPLEX FOODS

Data from reported outbreaks can be used to estimate the attribution of a subset of foodborne illnesses. This is problematic, however, when implicated food vehicles contain ingredients from more than one commodity. The presenter will discuss and contrast two methods of assigning outbreak-related illnesses to specific food commodities.

T3-B.1 Coleman ME; colemanMEllen@gmail.com
Coleman Scientific Consulting, NY

FRAMING HAZARD CHARACTERIZATION FOR GASTROINTESTINAL ECOSYSTEMS

Hazard characterization in the gastrointestinal (GI) tract can be framed as a complex but generalizable process, building on physiologically-based modeling for robust extrapolation of knowledge developed in animal studies or in vitro assays to estimate risks with attendant uncertainty in humans. Robust simulations of oral drug absorption and physiologically based pharmacokinetics/pharmacodynamics (PBPK/PD) identify many factors that likely influence deposition and clearance of pathogenic and commensal (non-pathogenic or avirulent) microbes in the GI tract. Physiological models of the GI tract are also good candidates for structuring the

evidence to support decisions about safety of engineered nanomaterials. The complexities of mucosal immune functions in the GI tract will be explored for pathogens, commensals, and nanoparticles interacting with innate and adaptive immune systems. Discussions will highlight advantages that such a multidisciplinary mechanistic approach can provide over empirical approaches for assessing emerging risks in animal and in vitro systems linked by common modes/mechanisms of action.

M2-D.1 Conolly RB; conolly.rory@epa.gov
US Environmental Protection Agency

CLONAL EXPANSION (CE) MODELS IN CANCER RISK ASSESSMENT

Cancer arises when cells accumulate sufficient critical mutations. Carcinogens increase the probability of mutation during cell division or promote clonal expansion within stages. Multistage CE models recapitulate this process and provide a framework for incorporating relevant data. CE models fit naturally within biologically based dose response (BBDR) models linking carcinogen exposure with tumor response. A recent BBDR model for formaldehyde (F) consists of submodels for dosimetry, for a mode of action characterized by regenerative cellular proliferation and DNA damage, and for CE, with the latter taking mode of action effects as inputs and describing resultant tumor incidence. BBDR modeling has recently been criticized, particularly for its use in low dose extrapolation. It was specifically suggested that F might exert a low dose mitogenic effect on cells with one mutation, something that would be difficult to measure but that would significantly affect risk. Data gaps are not unique to BBDR/CE models, and do not present an insurmountable obstacle to the use of mechanistic data for low dose extrapolation. A BBDR/CE model that lacks data on cells with one mutation brings the gap to our attention, but no new uncertainty is introduced. If data on this component of the overall relationship is lacking, the uncertainty exists regardless of the model used to describe the relationship. Suggesting that the BBDR model increases uncertainty because it helps to identify a data gap is equivalent to shooting the messenger! Moreover, numerous studies of preneoplastic lesions provide substantial prior knowledge that should be considered when parameterizing this part of the CE model. The main thesis of this presentation is that uncertainty in low dose extrapolation can be reduced through judicious use of relevant mechanistic data. Uncertainties in the BBDR model for F will be compared to the uncertainties, explicit or not, in models with less biologically detailed structures. (This work was reviewed by the USEPA and approved for publication but may not reflect Agency policy.)

W4-A.1 Cooke RM, Kousky C; cooke@rff.org

Resources for the Future

CLIMATE CHANGE: A PROBLEM OF OPTIMAL CONTROL OR RISK MANAGEMENT?

Banks, insurance companies and investors use capital requirements to buy down risk and keep the probability of insolvency less than 1-in-200 per year. Current integrated assessment models for the economic consequences of climate change balance the costs of abatement against the costs of climate induced damage to determine an optimal consumption path. In so doing they use nominal values for parameters which are highly uncertain. Various authors aver that optimizing expected consumption in this way courts risks in the order 1-in-20 to 1-in-100 of rendering the planet unfit for human consumption as we know it. We contrast optimal control and risk management approaches to climate change. Whereas optimal control seeks to maximize consumption, risk management buys down the risk of catastrophic loss. Hallmarks of the risk management approach-stress testing models, exploring the range of possible outcomes given a policy choice, and quantifying uncertainty via structured expert judgment-are illustrated with simple models. The policy landscape under a risk management approach is sketched.

W4-B.1 Corner A, Pidgeon N; pidgeonn@cardiff.ac.uk

Cardiff University

NOT YET A HOT TOPIC? AFFECTIVE AMBIVALENCE AND NANO-TECHNOLOGIES

Numerous studies have now demonstrated that the general level of familiarity with nanotechnologies is low. A low level of public awareness is one of the reasons that nanotechnologies can still be considered upstream, but it is well known that knowledge about a new technology is by no means the only factor that is likely to influence attitudes towards it. A range of studies have demonstrated that affect - the experience or feeling of emotion - is also an important determinant of how people evaluate risk information. In a nationally representative survey of 1,000 adults conducted in the US in 2008, a low level of familiarity with nanotechnologies was accompanied by a high degree of affective ambivalence. The majority of survey respondents were unsure how nanotechnologies made them feel, and had not yet developed a strong affective position. The degree to which participants were affectively ambivalent about nanotechnologies was found to impact on a range of other measures in the survey, including the way in which they evaluated short 'narratives' about specific nanotechnology applications, trust in the regulation of nanotechnologies, and perceptions of the stigma associated with particular nanotechnology risk issues. We explore the role that affect plays in determining attitudes towards nanotechnologies, and suggest that while nanotechnologies are upstream in terms of familiarity, they are also (currently) upstream in terms of affect.

T4-G.1 Cote I, Barone S, Dix D, Judson R, Edwards S, Devlin R, Avery J, Preuss P; cote.ila@epa.gov

US Environmental Protection Agency

THE NEXT GENERATION OF RISK ASSESSMENT

The landscape of risk assessment is changing to an extent that significant transformation of risk assessment is necessary. These changes are driven largely by phenomenal advances in molecular and systems biology, several recent and important reports from the National Research Council, and volumes of new test data from Tox21 and the European REACH programs. These drivers are prompting EPA to look anew at risk assessment. The resulting program is entitled "Advancing the Next Generation of Risk Assessment (NexGen)" and is a collaboration among: EPA, National Institutes of Environmental Health Sciences, National Human Genome Research Institute, and California's Environmental Protection Agency. The goal of NexGen is to incorporate recent advances in molecular biology, systems biology and gene-environment interaction into risk assessment. The initial effort focuses on health assessment and will span 18 months; a second phase will focus on exposure assessment. The specific objectives of NexGen are: 1) pilot implementation of the NRC's Framework for Risk Based Decision-making; 2) refinement of bioinformatics systems for knowledge mining and creation to serve risk assessment and; 3) development of prototype health assessments, responsive to the risk context and refined through discussions with scientists, risk managers, and stakeholders. The prototypes are focusing on broad evaluations of high throughput/high content bioassay data to augment, extend or replace traditional data. Additionally, we are evaluating: proof of concepts, value of information and decision rules for risk assessment. Where feasible, we are reverse engineering assessments based on new types of data to existing, robust, in vivo data-based health assessments that currently provide our best estimates of public health risks posed by chemical exposures. This presentation is a status report on the prototypes.

W4-E.2 Cousins AC, Shirai JH, Kissel JC; jkissel@u.washington.edu

University of Washington

ASSESSMENT OF THE CONTRIBUTION OF DERMAL PATHWAYS TO INDOOR EXPOSURE TO SVOCs

Increasingly available biomonitoring data provide evidence of widespread human exposure to large numbers of chemicals. In some cases, dominant exposure pathways are evident. However, in the case of non-occupational exposures to chemicals found in consumer products, multiple exposure pathways may be relatively important contributors. Although attempts to parse aggregate exposures are becoming common, data sets that actually permit use of a mass balance approach remain relatively rare. Even where mass balance is possible, use of uncertain or conservative estimates may conceal a gap between the sum of predicted inputs and observed out-

puts. Aggregate assessments often contain component estimates that vary dramatically in quality. Dermal exposures in particular are often dismissed on the basis of calculations that are not well considered. In the case of SVOCs that persist in indoor environments, chronic dermal exposures are inevitable. This is especially true in the case of chemicals present in bulk quantities in building materials such as plasticizers and flame-retardants. Credible estimates of the magnitude of those inevitable exposures are needed to inform future consumer product regulations. Prior experience with selected pesticide data (chlorpyrifos, 2,4-D, pentachlorophenol) from CTEPP suggests that dermal exposure contributed non-negligibly to children's exposures to those compounds in that study. Building on that work, we have constructed a fugacity-based indoor fate and transport model that includes a multi-component human with a credible skin barrier. Application of that tool to indoor exposure scenarios for multiple chemicals for which appropriate environmental and biomarker data are available is proceeding in pursuit of mass-transfer related factors that lead to consistent explanations for dermal phenomena across a range of chemicals. This work was supported in part by US EPA via STAR Grant RD-83184401. Results have not been reviewed by EPA and no Agency approval should be inferred.

T2-G.1 Cox T; tcxodenvr@aol.com

Cox Associates and University of Colorado

MODELS AND MECHANISMS OF DOSE-RESPONSE THRESHOLDS FOR PARTICULATE AND NANOPARTICLE-INDUCED INFLAMMATORY LUNG DISEASES AND LUNG CANCER

Many poorly soluble particles and nanoparticles, including various mineral dusts, act as lung carcinogens, and also cause sustained lung inflammation. Experiments in rats and a variety of other in vitro and in vivo data have shown apparent dose-response thresholds for lung inflammation and increased lung cancer risks from such sources. We briefly summarize some of the profound new insights on mechanisms of lung inflammation, injury, and carcinogenesis emerging from in vitro and -omics studies on affected lung cell populations (including cytotoxic CD8+ T lymphocytes, regulatory CD4+ helper T cells, dendritic cells, alveolar macrophages and neutrophils, alveolar and bronchiolar epithelial cells, goblet cells, and fibroblasts) and extracellular matrix (ECM) components (especially, elastin and collagen fibers); in vivo studies on wild-type and genetically engineered mice and other rodents; clinical investigation of cell- and molecular level changes in lung cancer and COPD patients; genetic studies of susceptible phenotypes (both human and animal); biomarker studies of enzyme and protein degradation products in induced sputum, bronchiolar lavage, urine, and blood; and epidemiological and clinical investigations of the time course of disease progression. To help interpret this wealth of mechanistic data and evidence, we propose a relatively simple computational model that explains chronic inflammation, irreversible degeneration of lung tissue, and increased lung cancer risk

as resulting from a cascade of positive feedback loops: a macrophage inflammation loop, a neutrophil inflammation loop, and an alveolar epithelial cell (AEC) apoptosis loop. Unrepaired damage results in clinical symptoms. The resulting model illustrates how to simplify and make more understandable the very complex dynamics of particulate-associated lung inflammation and disease, as well as how to predict the effects on disease risk of interventions that affect specific biological responses.

W1-F.6 Cragin DW; david_cragin@merck.com

Merck & Co.

MANAGING THE EMERGING THREAT OF CLOSTRIDIUM DIFFICILE

Over the past 30 years, infection by *Clostridium difficile* has become an increasingly important risk to health. Now, *Clostridium difficile* is the most common cause of infectious healthcare-associated diarrhea in the U.S.. It occurs in ~20% of hospitalized patients with antibiotic-associated diarrhea. In addition, during the last 10 yrs, death rates associated with *Clostridium difficile* have been increasing in the US, Wales, and England. In particular, rates in the US increased abruptly beginning in 2001, with a doubling of national rates from 2000 through 2003. Treating these infections presents a challenging risk management situation. *Clostridium difficile* is a bacterium that produces exotoxins that are pathogenic to humans. Infection by *Clostridium difficile* is characterized by damage to the gastrointestinal tract. The lesions are caused by the expression of two potent toxins, produced late in the growth cycle of the organism: toxin A and toxin B. One of the major risk factors for *Clostridium difficile* infection is treatment with antibiotics, yet treatment of *Clostridium difficile* infections also requires the use of antibiotics. This in-turn puts the patient at high risk for reinfection as does the damage to the intestine caused by the initial infection. Another major risk factor for *Clostridium difficile* infection is advanced age and this will be increasingly important as the US population ages. As a result of these special risk factors, new techniques and approaches will be needed to manage and mitigate the health risks posed by *Clostridium difficile*.

W4-C.3 Cretu O, Cretu V; cretuovidu@comcast.net

Cretu LLC

AN INTEGRATED APPROACH TO PROJECT RISK ANALYSIS

The paper presents an integrated approach of project cost and schedule risk analysis using Risk Based Estimate Self-modeling tool (RBES). The integrated approach creates an Uncertainty Zone which captures the project's triad (scope, cost, and schedule) on conditions of cost and schedule uncertainties. Uncertainty Zone is defined through Monte Carlo Simulations by blending together RBE's two main components: base cost and schedule, and risks for the cost and schedule. Ultimately, the integrated approach gives a comprehensive view of a project's risk environment. The paper discusses: (1) the probability bounds (p-box) that expresses the base cost

uncertainty by tying together its components (epistemic - variability, and random-market conditions); (2) the need to limit project risk analysis to only significant events that may push the project's performance outside its base variability; (3) the importance of having a comprehensive risk description (SMART description, and risks conditionality); (4) risk assessment - analysis, and risk response - monitor - control as main tiers of project risk management; and (5) performance measurement of cost risk analysis impact on project's bottom line.

M2-D.2 Crump KS; KennyCrump@email.com

Louisiana Tech University

BBDR MODELS AND THE PROBLEM OF LOW-DOSE EXTRAPOLATION

Biologically-based dose-response (BBDR) models have been profitably used to evaluate proposed mechanisms of toxicity and identify data gaps related to these mechanisms. However, these models have not proven useful in improving quantitative predictions of low-dose human risk, for several reasons. BBDR models do not eliminate the need for empirical modeling of the relationship between dose and effect, but only move it from the apical response in the whole organism to a lower level of biological organization. E.g., a BBDR model may express the probability of cancer in terms of intermediate responses such as rates of mutation and/or cell proliferation. But one or more of these rates must then be related quantitatively to exposure, which will still require empirical modeling that will involve the same very large and well-known uncertainties as occur in empirical modeling of apical responses. This problem becomes even grimmer if dose-response modeling is required for multiple intermediate responses. In addition, BBDR modeling introduces significant new sources of uncertainty. Quantitative predictions are limited by questions involving the relevance of data and by inter- and intra-individual heterogeneity. Finally, BBDR models usually are based on data in the wrong species. If the dose response in an experimental animal species was known with certainty, there would still be considerable quantitative uncertainty about the risk in humans. Even if these problems were not present the effort required to developing BBDR models would prevent them from being developed for more than a very small number of toxic substances. An appreciation for both the profitable uses and limitations of BBDR models risk assessment is needed to guide allocation of resources to support risk assessment of toxic substances.

T4-C.1 Cullen AC, Anderson CL, Zelinka M; alison@u.washington.edu

University of Washington

PERCEPTIONS AND MEASUREMENTS OF WEATHER AND CLIMATE AMONG THE RURAL POOR IN VIETNAM

Perceptions of climate change and its impact on livelihood among rurally based farming and fishing commune dwellers in Vietnam are shaped by a range of fac-

tors. In a primary survey of 1165 individuals living in three communes in Ha Tinh province we gathered data regarding observations about stability or change in climate conditions, concerns about agricultural production, health, food security, and general orientation toward risk and the future. Related temporal analyses of meteorological and economic conditions formed the empirical basis for comparison. High quality datasets from the National Climatic Data Center, the Joint Typhoon Warning Center, and the General Statistics Office of Vietnam provided temperature, precipitation, agricultural yield, fishing yield and extreme weather event data. We considered evidence of anchoring in response to recent extreme weather events. We also gauged the impact of predictors including gender, occupation, life experience, the stakes of potential climate related disruptions to livelihood, and risk attitudes, on an individual's likelihood of reporting changes in the climate and associated level of concern.

W3-F.3 Cummings CL; christopherlcummings@hotmail.com

North Carolina State University

ADAPTING THE SOCIAL AMPLIFICATION OF RISK FRAMEWORK FOR THE 21ST CENTURY

Today's media landscape is constantly changing-current risk communication frameworks must adapt to meet that change. Emerging social media platforms and tools are both broadening and stratifying how risk messages are created, disseminated, repeated, quoted in and out of context, and mashed-up with other content within and across communication networks. Kasperson's Social Amplification of Risk Framework (SARF) illustrated how risk perceptions are altered socially and individually and helped demonstrate how human perceptions of risk messages are amplified and attenuated through social constructs. The SARF noted that risk messages originate from empirically-informed, scientifically-based study and are products of industry, government agencies, and academics who frame issues to be channeled through intermediaries to the public. These intermediaries, identified primarily as media sources, act as amplification stations that alter message salience. However the evolution and democratization of communication through new technologies problematizes the SARF as the public themselves have turned from consumers into producers of risk messages. This warrants investigation and elaboration of how risk messages amplify and attenuate issue-specific and broad-based risk perceptions. This paper seeks to further the descriptive capacity of the SARF to suit contemporary and emerging arenas in which risks are communicated among diverse audiences. This work examines three contemporary case studies of risk issues in emerging contexts to support a reconceptualization of the SARF. It presents data to support a model of social amplification of risk that is not based on a linear broadcast model of communication; instead, the model presented herein accounts for risks amplified through decentralized and localized communication processes.

P19 Cunningham FH, Fiebelkorn S, Meredith C; clive_meredith@bat.com
Group R&D, British American Tobacco

A RISK ASSESSMENT PARADIGM FOR TOBACCO SMOKE TOXICANTS: SEGREGATION USING A MARGIN OF EXPOSURE ANALYSIS

Scientific literature detailing the identity of tobacco smoke toxicants that contribute to adverse health effects of cigarette smoking has expanded over the last 20 years. There has been a trend toward providing a quantitative risk estimate of the contribution of individual toxicants to disease with the aim of establishing priorities for risk reduction research. We propose adoption of the Margins of Exposure (MOE) model, following European Food Safety Authority (EFSA) guidelines. This model permits evaluation of both genotoxic and carcinogenic compounds and we propose its application to toxicants found in tobacco smoke. An MOE is a ratio between a benchmark dose (derived from existing toxicological dose-response data) and the specific human exposure. Compounds with computed MOEs >10,000 accompanied by logic dialogue are considered to be “low priority for risk management actions”. Our approach is to calculate MOE values from a range of published studies to determine consistency within available data sets. We have, where relevant, taken all available toxicological studies and computed individual MOEs. Computed MOEs enable segregation of toxicants into high and low priority groupings for risk reduction research depending on their relationship to the critical MoE value of 10,000. Certain classes of compound, e.g. aldehydes, that are found in tobacco smoke may have a common Mode of Action (MOA) and therefore the MOE approach can be refined to incorporate groups of structurally (and toxicologically) related chemicals leading to the concept of a group MOE. To proceed with such a model requires consideration of the MOA for groups of structurally related chemicals together with a rigorous evaluation of the tissue dose for individual toxicants or their metabolites. We propose that estimation of MOEs for smoke toxicants is a useful first step towards the prioritisation of risk reduction research and towards development of more complex, but physiologically more relevant risk assessment paradigms.

T3-C.4 Dalrymple KE, Shaw BR, Brossard D; kdalrymple@wisc.edu
University of Wisconsin, Madison

THE ROLE OF THE MASS MEDIA IN ENCOURAGING ENVIRONMENTAL BEHAVIOR CHANGE: LESSONS IN SOCIAL MARKETING AND ENVIRONMENTAL RISK COMMUNICATION

Aquatic invasive species (AIS) pose an increasing threat to the health of our nation's natural ecosystems. Although many national and state institutions have implemented campaigns in order to increase public awareness of AIS, the success of these campaigns in encouraging more positive environmental behaviors remains unclear. Previous research in the field of risk communication has illustrated the importance of the mass media in increasing public understanding and judgment of environmen-

tal risks. Specifically, empirical work has indicated that variables such as quantity of media coverage or message tone can have important effects on public perceptions of risk. Little research, however, has focused on the influence that media messages may have on changes in environmental behaviors. Using the theory of planned behavior as a theoretical framework, we explore the possible influence that media messages and personal motivations may have on compliance with positive AIS related behaviors. We examine these relationships using data from a random sample survey of Wisconsin residents (N=507) - a state that continues to struggle with the spread of aquatic invasive species and viral hemorrhagic septicemia (VHS). Controlling for demographics, our results indicate that both media use and personal motivations are predictors of compliance with positive AIS behaviors. Specifically, boaters and transient anglers were most motivated by protecting Wisconsin's fisheries and doing what friends and family think is right (i.e., social norms). Attention to all forms of mass media - traditional news media, internet use, and attention to AIS related public service announcements - was positively related to compliance with positive AIS behaviors. These results, which account for almost 35 percent of the variance in the outcome, demonstrate the importance of both a mixed media approach as well as the consideration of personal motivations when implementing future social marketing campaigns related to environmental risks.

T4-A.4 Dana GV, Nelson KC; gvdana@gmail.com
Dana and Sharpe Risk Associates

SOCIAL LEARNING IN PARTICIPATORY ENVIRONMENTAL RISK ANALYSIS

Social learning is critical when engaging stakeholders in ecological risk analysis (ERA) of emerging technologies, because investigating complex socio-ecological systems in which their risks occur depends on learning diverse information and perspectives. The social component occurs when people engage with each other and share diverse knowledge and experiences to develop a common framework of understanding and a foundation for collective action. Efficacious risk-related decisions can benefit from social learning outcomes, which include collective understanding of a technology's potential risks, the conditions in which they may materialize, and joint support for specific solutions. We investigated social learning among 22 diverse stakeholders during a 3.5-day participatory ERA workshop evaluating potential threats from genetically modified (GM) maize to South African biodiversity. Participants evaluated the ERA process as containing components and attributes important for engendering social learning, such as diverse participants, open communication, constructive conflict management and extended engagement. We found that social learning occurred, as participants engaged with new information and diverse perspectives, began thinking systemically and modified their risk perceptions. Participants did not, however, develop a shared understanding of the ERA process or highest priority

risks. We suggest that carefully designed participatory processes can produce social learning about other stakeholders, complex socio-ecological systems, and potential risks of emerging technologies in short time periods, but that longer engagement is needed in order to develop a shared understanding of the overall risk situation and collective support for solutions.

W4-H.2 Davies GJ, Kendall G, Soane E, Li J, Rocks SA, Pollard SJT; g.davies@cranfield.ac.uk

Cranfield University, School of Applied Sciences, UK, University of Nottingham, School of Computer Science, UK, London School of Economics, UK

AN AGENT-BASED MODEL FOR RISK-BASED REGULATION

The need for an established evidence-base framework for government decisions about risk has become the new mantra, yet the process of brokering scientific evidence is poorly understood, affecting the transparency of decisions made. The time-frame and number of participants involved often renders it impossible to model the impact individual personalities and positions of power has using conventional modelling (Davies et al in press). Agent-based techniques, however, have the capacity to grow the type of complexity that characterise these decisions (e.g. Neuberg and Bertels, 2003). This research has developed an agent-based simulation model that brings together social science insights in the context of government decision making. Semi-structured interviews were carried out with experts from three government decisions; regulation, environmental planning and policy development. Then drawing upon a historic knowledge base (e.g. French and Raven, 1959; Costa and MaCrea, 1999), combined with evidence support logic (Shafer, 1976; Baldwin, 1985; Bowden, 2004) the model has been designed to permit the user to vary components of the interacting agents and of the decision-making procedure. This demonstrates the influence that personality and power has on agent receptivity (e.g. Handy, 1999) and the confidence attached to a particular line of evidence. The simple two-agent model, characterising the regulator/operator relationship, captures the influence personality and power has on a recipient's confidence in the sufficiency of evidence being submitted. Development of the model is a novel step forward because it goes beyond the scope of current risk management frameworks. It permits the user to explore the influence that participants have in weighing and strengthening different lines of evidence and the potential impact this has on the design of regulatory styles and selection/make-up of expert elicitation panels.

W1-D.3 Davis TB, Long MC, Zerbe RO; tbdavis@u.washington.edu

University of Washington

THE DISCOUNT RATE FOR PUBLIC PROJECTS: INCORPORATING HETEROGENEITY IN CITIZEN PREFERENCES

Following in the spirit of the Kaldor-Hicks rule, we argue that heterogeneity across citizens' time preference rates for public projects should be incorporated in a way that does not match current practice in Benefit-Cost Analysis. We propose an alternative social time preference rate which gives all citizens equal standing, and is derived by first computing the average of each citizen's present value of a certain future dollar, and then backing out the social time preference rate that yields this average present value. Assuming heterogeneity across citizens, the result is a monotonically decreasing social time preference rate, which we term the "Equity Rate". As t goes to infinity, this Equity Rate converges towards the rate of the individual citizen with the lowest time preference rate. The hyperbolic decline of the Equity Rate is dictated exclusively by the aggregation of preferences, even if no citizen individually prefers a declining rate for social projects. The Equity Rate is related to the social discount rate proposed by Weitzman (2001), but motivated differently; the Equity Rate is motivated by giving each citizen equal standing, rather than assuming each expert has an equal chance of knowing the "correct" social discount rate. Finally, we show that as the time horizon for benefits lengthens, the share of the population willing to vote in favor of projects that pass the Kaldor-Hicks test dwindles, and we get a divergence between projects that would be approved by a benefit-cost analyst and projects that would be approved in a referendum.

M3-I.1 Davis JA, Gift J; davis.allen@epa.gov

United States Environmental Protection Agency

APPLICATION OF THE RAO-SCOTT TRANSFORMATION TO ACCOUNT FOR INTRALITTER CORRELATION IN THE ABSENCE OF INDIVIDUAL ANIMAL DATA

To quantitatively analyze developmental endpoints during the derivation of chronic human health toxicity values, the U.S. EPA has incorporated specific dose-response modeling methodologies that utilize the nested dichotomous models included in U.S. EPA's Benchmark Dose Software (BMDS). One statistical issue addressed by these models is intralitter correlation, the tendency of litter mates to respond more similarly to one another when compared to pups from other litters within the same exposure group. The nested dichotomous models differ from the standard dichotomous models in that nested models require individual animal data. Unfortunately, individual animal data is not available for all datasets, such as those drawn from publications presenting incidences only by exposure group. This presentation outlines the Rao-Scott transformation, an alternative statistical approach to account for intralitter correlation when individual animal data are not available. The Rao-

Scott transformation allows for the treatment of correlated binomial random variables (e.g., effects within the same litter) as if they were uncorrelated, allowing the use of standard dichotomous models. A proof-of-concept case-study is presented, first modeling developmental toxicity endpoints reported as individual animal data with nested dichotomous models, and then modeling the same developmental endpoints using standard dichotomous models with Rao-Scott transformed summary data. The results of these two modeling approaches will be compared to assess the necessity, precision, and potential application of the Rao-Scott transformation in human health risk assessment. Disclaimer: the views expressed are those of the authors and do not necessarily reflect the views or policies of the U.S. EPA

W1-D.1 Davis ME; mary.davis@tufts.edu

Tufts University

ECONOMIC APPLICATIONS FOR IMPROVING DOSE-RESPONSE CURVES: THE CASE OF AIR POLLUTION

The lack of adequate historical air pollution data represents an important problem for exposure classification in epidemiologic studies of chronic disease. The temporal and spatial availability of pollution monitoring data becomes scarcer the farther back in time exposure begins, and obtaining unbiased estimates of lifetime dose is difficult. The studies that have access to quantitative exposure data are typically limited to current or recent exposures for which air pollution monitoring data are readily available, with little or no information available on past levels. Often, point estimates or averages of current exposure are assumed to be representative of lifetime levels or related in some linear fashion to earlier exposures, and fail to account for changes in exposure patterns over time and place. Given the relative paucity of direct air pollution monitoring data, it is useful to define alternative variables that are correlated with exposure that are more widely accessible historically. This work explores economic trends as one such surrogate exposure marker using two extensive longitudinal data sets of small particle air pollution from New Jersey (1971-2003) and California (1980-2006). This study applies a mixed modeling approach to estimate air pollution trends as a function of changing economic conditions and regulatory policies, among other controlling factors. The results of the analysis provide evidence to suggest a significant role for the Economy in understanding air pollution trends in the US. The evidence suggests that periods of economic growth prompt higher than average air pollution concentrations, while the opposite is true for economic downturns. These results provide initial evidence to suggest that economic data may represent a useful surrogate marker to update dose estimation in chronic epidemiologic studies, although more work in this area is needed.

T4-F.3 Davis ME; mary.davis@tufts.edu

Tufts University

PERCEIVED SAFETY RISK AND REGULATORY COMPLIANCE IN THE COMMERCIAL FISHING INDUSTRY

Commercial fishing is consistently ranked as one of the most dangerous occupations in the US, with a reported fatality rate almost 30% higher than logging, the second ranked occupation in terms of job fatality risk. Despite these hazards, surprisingly little is known about how fishermen perceive the risks they face on the water, or the degree to which they comply with existing safety regulations. To bridge this critical information gap, a study was conducted to explore the level of safety preparedness and risk perception in the Maine commercial fishing fleet. A safety survey was randomly administered to 259 fishing boat captains while operating at sea. The sample was regionally representative of the Maine inshore fishing industry, spanning the entire coastline and representing the largest study of its kind nationally. Each fishing boat captain answered questions regarding the safety equipment on board, as well as education level and safety training, demographic characteristics, and risk preferences. The survey results provide clear evidence of general risk-seeking tendencies and irrational risk perception in this population. Commercial fishing captains were often involved in other dangerous occupations (part-time firemen, loggers, truckers, etc.), and were more likely to smoke and less likely to wear their seat belt than the typical American male. As a general rule, fishermen failed to recognize the role that accidents, weather, or other elements outside of their control play in fishing risk. They rated their occupational risk as average, despite substantial evidence to the contrary. Most fishermen believed that the risks were isolated to fishermen that weren't careful, or to certain 'dangerous' off-shore fisheries. Nearly 9 out of 10 fishermen felt that driving a car was more dangerous than fishing. These results may be attributable in part to the unique fishing culture and the strong sense of independence among fishermen, as well as the persistence of denial as a coping mechanism.

M2-B.3 Davis JM; davis.jmichael@epa.gov

US Environmental Protection Agency

NOMINAL GROUP TECHNIQUE AND RESEARCH PRIORITIES FOR COMPREHENSIVE ENVIRONMENTAL ASSESSMENTS OF NANOMATERIALS

U.S. EPA is sponsoring a series of workshops to help identify and prioritize information gaps that should be addressed to support future comprehensive assessments of selected nanomaterials. A key objective is to go beyond merely enumerating "research needs" and to discern priorities among possible research directions. Two major considerations figure into designing these workshops: (1) a structured decision process rather than a "free discussion" format to determine priorities; (2) a diverse, multi-disciplinary, multi-stakeholder group to consider the issues. The workshops are

conducted using Nominal Group Technique (NGT), which is a process whereby a set of individuals identify and rank a number of choices. It affords an equal opportunity for participants individually to state which choices they view as highest priorities. If numerous choices exist, they may be consolidated into a more manageable number. A multi-voting process is then used to rank the choices. Participants in the EPA workshops review (in advance of the workshop) a document that describes selected nanomaterial “case studies” structured around a framework known as comprehensive environmental assessment (CEA). CEA is a holistic approach to risk assessment that encompasses the product life cycle, fate and transport, exposure-dose, and ecological as well as human health effects. Information gaps are posed as questions and listed in the case studies as a starting point for the participants in their deliberations. Among the outcomes of this process are a short list of top priorities and a longer list of “known unknowns” for consideration by researchers and research planners. By providing opportunity for interaction among persons with diverse perspectives, this process may also help identify “unknown unknowns” and thereby avert unintended consequences of an emerging technology. Disclaimer: This abstract does not necessarily reflect the views or policies of U.S. EPA

T2-I.4 Davis TB, Zerbe RO; tbdavis@u.washington.edu
University of Washington

COMMONALITIES IN BENEFIT COST ANALYSIS: A REVIEW OF PRINCIPLES AND STANDARDS FOR TREATMENT OF RISK

We propose an analysis of white papers commissioned from experts in benefit cost analysis (BCA). Our presentation will draw from 12 white papers commissioned from experts by the Center for BCA at the University of Washington supported by the MacArthur Foundation. These papers review the best practices of BCA in 12 separate types of programs. Each of the experts identifies principles and standards for BCA specific to their field. These papers are not a random sample, but represent the opinions of experts; we rely on the authors’ expertise for validity. Our presentation and analysis is conducted in three steps. First, we use inductive research logic to identify a typology of characteristics for which the authors give specific recommendations for principles and standards. These characteristics include recommendations on treatment of risk, uncertainty, standing, discount rate, presentation, and moral sentiments. Second we identify similarities between recommendations for each characteristic in each area examined. We focus on the treatment of risk. We contextualize these standards within the existing literature from the specific field of BCA. Finally we identify and summarize the common recommendations for each characteristic so we may offer generalizations that apply across all types BCA. The net result is a set of principles and standards as a baseline for all BCA, and specific recommendations for individual fields. For this presentation we highlight the diverse treatment of risk across programs.

W4-D.1 Dearfield K; amichida@hotmail.com

US Department of Agriculture-FSIS

OVERVIEW OF THE INTERAGENCY MICROBIOLOGICAL RISK ASSESSMENT GUIDELINE

The Interagency Microbiological Risk Assessment Guideline is for U.S. Government microbiological risk assessors, government contractors, and the general microbiological risk assessment community to use when conducting microbial risk assessment. The Guideline is flexible so that it can be applied in a variety of contexts. It is based on the 1983 NRC chemical framework that has four steps: hazard identification, hazard characterization (dose-response), exposure assessment, and risk characterization. It also has an expanded planning and scoping chapter that is based on the risk assessment experience of the 35 workgroup members that authored the Guideline and other sources, such as an EPA workshop on Problem Formulation. The Guideline is planned to include several volumes with different topics of focus. The volume currently undergoing OMB review is broadly focused on infectious diseases associated with the gastrointestinal tract and fecal/oral transmission in mainly food and water. Although many aspects of airborne scenarios are included in this volume, future volumes may include more details on airborne microbial risks, inhalation and dermal exposures, and genetically engineered microorganisms. This presentation will include: an overview of the scope of the information that is covered in the Guideline, a summary of the concept used for development of the Guideline, and a description of the processes used to develop the Guideline.

M3-H.4 Decker DK; debra_decker@hks.harvard.edu

Harvard University

THE IDENTIFICATION OF HARMS

While harm has been identified traditionally in terms of mortality/morbidity and economic losses, new efforts are underway to identify broader interests that in turn could then be used by risk analysts to better measure harms including to specific segments of society over time. This presentation will consider various current efforts to identify and quantify individual and national interests ranging from the Helsinki Process Track on Human Security to the Commission on the Measurement of Economic Performance and Social Progress (led by Joseph Stiglitz, Amartya Sen, and Jean-Paul Fitoussi).

W3-H.2 Delgado J, Longhurst P, Snary E, Pollard S; j.delgado@cranfield.ac.uk

Cranfield University

APPLICATION OF TOTAL SYSTEMS AND NETWORK ANALYSIS IN THE PREVENTION OF EXOTIC ANIMAL DISEASE OUTBREAKS

Understanding the import routes an exotic animal disease [EAD] is of utmost importance to prevent an outbreak. Low likelihood events, which are capable of causing high impacts, e.g. UK 2001 FMD Crisis, are of particular concern. Preven-

tion of EADs involves the cooperation of multiple entities, each playing a specific role in detection and elimination of disease agents. The system results from complex assemblages of components, with disease outbreaks resulting from a succession of failures in detecting and containing the agent. This research presents a new method for analysing potential import routes of an EAD being introduced into UK. To date import risk assessments focussed on the study of predetermined exposure routes, which fails to understand system function as a whole. From these observations we propose a simple model that allows an understanding of the system's behaviour and the role played by each entity. The method is based on total systems and network analysis techniques. The network structure determines pathways over which a disease agent can flow from source to receptor thus resulting in an outbreak. There are multiple pathways, direct and indirect, between two interconnected components. A connection between two adjacent components results from failure to detect and/or contain the disease agent. Failure causes are captured using a feature, events and processes list. Interviews and an expert elicitation were used to collect data on the rate and causes of failure. The aim of this research is to improve understanding of the systemic relationships responsible for introduction of an EAD and to predict its behaviour. The method will test the resilience of the system to EAD incursions, will calculate potential pathways emanating from gaps and weaknesses in the preventative barriers and will identify key areas where intervention is most effective. This presentation will highlight method development and discuss the data resulting from its application to Classic Swine Fever.

P.64 Demuth JD; jdemuth@ucar.edu

Colorado State University / NCAR

WEATHER FORECASTERS' SCHEMAS AND THEIR CONSTRUCTION OF FORECAST MESSAGES

The ultimate purpose of weather forecasting is to serve society by communicating useful information that enhances people's decision-making and reduces their risk to life and property. How people interpret and respond to forecast messages is inextricably linked to the messages they receive, which traces back to the creators of those messages—that is, to weather forecasters. Developing an understanding of the forecast and warning communication process therefore must include consideration of weather forecasters. The National Weather Service (NWS) has myriad forecast products (i.e., messages) for which a weather forecaster can construct the bulk of the message content within the broader scope of the product purpose. Little is known about why an individual NWS forecaster creates forecast messages in the way that he or she does, yet this knowledge is essential to understanding and improving the communication of weather risks. I will explore the role of schemas as important elements in forecasters' cognitive processing that influence how they perform their jobs and, in particular, how they construct forecast messages. I will conclude by proposing

a research agenda to study and develop an understanding of forecasters' schemas in five key areas: (1) types of forecasters' schemas; (2) creation, modification, deactivation of forecasters' schemas; (3) activation of forecasters' schemas; (4) forecasters' cueing of audiences' schemas; and (5) the role of schemas and technology in weather.

M2-H.4 Douglas HE; hdouglas@utk.edu

University of Tennessee

COHERENCE, PLAUSIBILITY, AND WEIGHT OF EVIDENCE ANALYSIS

In weighing sets of evidence from multiple disciplines, experts construct explanations of why the evidence (even disparate evidence) looks the way it does. Whether or not these explanations are reliable construals is one epistemic question. Whether or not the explanations are even plausible is another. In this talk, I will examine the extent to which plausibility constrains the explanations offered for sets of evidence, exploring how background knowledge sets the boundaries of plausibility for weight of evidence analyses. If background knowledge is crucial for determining plausibility (and thus the scope of the competing explanations), then how the appropriate background knowledge gets utilized becomes a central concern. In addition, whether or not the various background knowledge from multiple disciplines can be brought together in a coherent way is crucial. And finally, the coherence of the explanations with the available evidence must be assessed. This talk will address how both plausibility and coherence can constrain weight of evidence analyses, regardless of how the weight of evidence analysis proceeds once these limits are established (whether through Bayesian analysis, expert judgment, logical ranking, or another approach). The need for assessment of plausibility highlights the following: 1) the importance of an explicit understanding of what makes something plausible; 2) the importance of successful cross-disciplinary collaboration in any weight of evidence analysis; 3) the importance of a clear and functional conception of coherence, whether it be simple consistency or something stronger.

W2-A.3 Doyle EA; doyle.elizabeth@epa.gov

US Environmental Protection Agency

POSSIBLE APPLICATION OF CUMULATIVE RISK ASSESSMENT TO DRINKING WATER REGULATION

In March 2010, EPA released the Drinking Water Strategy: A New Approach to Protecting Drinking Water and Public Health. In the Strategy, the Administrator of EPA announced an effort to develop a new approach to expand public health protection for drinking water by going beyond the traditional framework that addresses contaminants one at a time. The new approach is intended to increase the efficiency and reduce the time required to evaluate contaminants, and to take advantage of strategies for enhancing health protection cost-effectively. One aspect of a multi-contaminant approach is to consider the potential health impacts of groups of

contaminants. EPA has existing guidance outlining a number of approaches to cumulative risk assessment. In addition, other agencies have also developed approaches that may lend themselves to this activity. As groups of chemical contaminants are identified, they must be evaluated for their attributes, and how best to match a risk assessment approach to the chemical groups. As with all risk assessment issues, one size does not fit all. The approach to assessing risk for any chemical group must be made on a case-by-case basis.

M2-F.3 Drew CH, Anderson B, Beard SD, Brenner AT, Davis HL, Dilworth CH, O'Donnell CM, O'Fallon LR, Ryker SJ, Shipp SS; drewc@niehs.nih.gov

National Institute of Environmental Health Sciences, Science and Technology Policy Institute

EVALUATION METRICS FOR RISK COMMUNICATION

The National Institute of Environmental Health Sciences is developing metrics for evaluating activities, outputs and outcomes resulting from its Partnerships for Environmental Public Health program (PEPH). PEPH is an umbrella program supports a variety of research, outreach, and education activities to prevent, reduce, and eliminate diseases and adverse health outcomes that result from environmental exposures. A hallmark of this program is the active engagement of communities through the many stages of the environmental public health projects. During the development of the PEPH program in 2007, the grantee community indicated that evaluation metrics for partnerships, leveraging, communication, education/training, and capacity building are critical needs. Developing tangible metrics is an essential part of understanding the impacts and outcomes of research and intervention program activities. This presentation will provide an overview of the recently developed, draft PEPH Evaluation Metrics Manual. Examples of metrics that may be applicable to a variety of risk communication activities, products and impacts will be provided. For example, dissemination activities might include developing a communication strategy, developing content for messages, determining the media/format of messages, and following up with target audiences. Outputs may range from traditional printed materials (reports, pamphlets, leaflets, posters), to internet delivery (email, websites, pod casts, blogs, twitter, face book), audiovisual materials (videos, public service announcements, and personal contacts (community forums, health fairs, home health visits, use of promotoras, etc.). Potential impacts could include increased understanding of environmental health messages, secondary transfer of information, and behavior change. More information about the PEPH program is available at: <http://www.niehs.nih.gov/research/supported/programs/peph/index.cfm>.

M3-F.3 Drews F; drews@psych.utah.edu

University of Utah

ADOLESCENTS AND DECISIONS: SCIENCE CENTERS AS RESOURCES

Adolescents tend to be more dependent on their rapid, intuitive, affective 'System 1' due in part to their immaturity and lack of development of the analytical and rational 'System 2'. They tend to utilize so-called 'hot' rather than cool or reasoned approaches to decision-making, resulting in sensation-seeking and related youthful behaviors. Several research-based examples will be reviewed. We will discuss how some of the approaches noted by the other speakers might be utilized in aiding the growth, awareness, and education of adolescents and other System 2 'impaired' populations. Much of the time will be allocated to dialogue with session attendees.

W3-C.1 Driedger SM, Jardine CJ, Furgal C, Cooper EJ, Bartlett J; michelle_driedger@umanitoba.ca

University of Manitoba, University of Alberta, Trent University

H1N1 RISK AND TRUST: LEARNING FROM FIRST NATIONS AND METIS EXPERIENCES

Risk communication can be difficult when there have been historical legacies of mistrust, such as those that exist amongst many First Nations and Metis peoples in Canada. Developing appropriate messaging is even more challenging in situations of public health outbreaks, like the most recent H1N1 influenza pandemic. This presentation will focus on the experiences of urban First Nations and Metis living in Winnipeg, Manitoba, Canada as they discussed their concerns of safety and trust around information regarding protective behaviours and risks associated with H1N1 as well as the availability and uptake of the H1N1 vaccine. Using a combined framework around trust - the dual mode model of trust and confidence and examining how negative bias and prior attitudes influence the uptake of risk messaging - we examine where participants raised concerns about their confidence and trust (or not) of public health messaging surrounding protective behaviours and the safety of the vaccine. In May 2010, mixed gender focus groups of men (n=18) and women (n=18) between the ages of 18-34 were conducted, as this age range was considered to be the segment of the population most vulnerable to H1N1. Many people expressed concerns over the safety of the vaccine, where some felt that the vaccine had been inadequately tested. Many people also felt they were unprepared (both in terms of information on self-protection and the availability of protective health supplies) for managing the outbreak. More importantly, participants spoke of other safety concerns that were more pressing to them than pandemic H1N1. These study results highlight how public health agencies need to pay more attention to the specific socio-economic and cultural contexts of First Nations and Metis peoples when planning for, managing responses and communicating risks associated with pandemic out-

breaks. These results will also inform a much larger multi-year study being conducted about trust in decision-maker action across three different risk issues among First Nation, Metis and Inuit peoples in Canada.

M4-F.1 Dutt V, Gonzalez C; varundutt@cmu.edu

Carnegie Mellon University

PHYSICAL REPRESENTATION AND PROPORTIONAL THINKING ON CLIMATE CHANGE

The atmosphere's carbon-dioxide (CO₂) level has increased very rapidly over the past decade (IPCC, 2007). The increase has followed a non-linear path where the increase is larger in more recent years and smaller in early years. A number of risky consequences are associated with a future increase in the CO₂ level. Thus, a correct human evaluation of the future CO₂ level is a necessity. Amidst this necessity, research shows that people often respond linearly to a non-linear increase in a level (like a non-linear increase in the CO₂ level). On account of the linear response, humans tend to underestimate the non-linear future CO₂ level. This underestimation makes people follow a "wait-and-see" approach, under which people prefer to defer actions rather than take immediate actions against the CO₂ increase. In this paper, we demonstrate people's linear response on non-linear level problems and show that this is a robust problem of human reasoning, as it happens for both a climate (CO₂) and non-climate (marble) example. In a first experiment, participants respond by predicting the value of a CO₂ level when the level's path is constant, linear or non-linear over time (the path is presented on a graph). People are found to underestimate the non-linear CO₂ level. We suggest a "physical intervention" that may be effective in the reduction of people's linear response (the intervention is to present the level using an imagery rather than using a graph). In a second experiment, participants draw the level's path in two separate representations, physical and graphical, for the climate and non-climate example. Although people underestimated the level in both the climate and non-climate example in the graphical representation, the underestimation is reduced in the physical representation, showing the effectiveness of the intervention. Policy implications of findings on the wait-and-see approach are discussed.

P.101 Effio D, Kroner O, Maier A, Hayes B, Willis A; kroner@tera.org
Consortium of Eastern Ohio Masters of Public Health; Toxicology Excellence for Risk Assessment (TERA); Indiana Department of Environmental Management

AN INTERACTIVE WEB-BASED APPROACH TO RISK ASSESSMENT FOR RESOURCE EFFICIENCY AND PUBLIC HEALTH PROTECTION: STATE ENVIRONMENTAL AGENCY RISK COLLABORATION FOR HARMONIZATION (SEARCH)

U.S. state environmental agencies are charged with making risk management decisions that protect public health and the environment while managing limited technical, financial, and human resources. Meanwhile, the federal risk assessment

community that provides risk assessment guidance to state agencies is challenged by the rapid growth of the global chemical inventory. When chemical toxicity profiles are unavailable on the U.S. Environmental Protection Agency's Integrated Risk Information System (IRIS) or other federal resources, each state agency must act independently to identify and select appropriate chemical risk values for application in human health risk assessment. This practice can lead to broad interstate variation in the toxicity values selected for any one chemical, and calls into question the scientific credibility of health risk assessments based on these values. Within this context, this paper describes the decision-making process and resources used by states in the absence of federal guidance. The risk management of trichloroethylene (TCE) in the U.S. serves as a useful case study to demonstrate the need for a collaborative approach toward identification and selection of chemical risk values. The regulatory experience with TCE is contrasted with collaborative risk science models, such as the the European Union's efforts in risk assessment harmonization. Finally, we introduce State Environmental Agency Risk Collaboration for Harmonization (SEARCH), a free online interactive tool designed to help create a collaborative network among state agencies to provide a vehicle for efficiently sharing information and resources, and for the advancement of harmonization in risk values used among U.S. states.

W2-F.2 Eisinger F, Bouhnik AD, Malavolti L, Le Coroller Soriano AG, Julian-Reynier C; eisingerf@marseille.fnclcc.fr

InsERM U-912

FAMILIAL RISK OF CANCER - IT IS THE TARGET THAT MAKES THE ARROW PROBABLE

How layperson understands and constructs familial risk of cancer is critical since efficient but risky risk mitigation is at stake. A national cross-sectional survey was launched by the French Ministry of Health aimed at adult cancer patients two years after their diagnosis. Among the 13,923 patients identified, 6,957 were eligible to participate in this study and 4,460 (64.1%) answered the telephone administered questionnaire. One of the aims of this study was to describe two-year cancer survivors' perception of the cancer risk running in their family, and to describe how frequently these survivors recommended cancer screening to their relatives. One participant out of every two (50.8%) reported that they thought their relatives' risk of cancer was greater than that of the relatives of unaffected persons. Overall, 61.1% of the participants had already advised relatives to undergo cancer screening. A multivariate analysis showed that the factors independently associated with a higher perception of the familial risk cancer were having children ($p < 0.001$) and a younger age at diagnosis ($p < 0.001$). In addition to these factors, prostate and UADT/lung cancer sites were associated with a lower perception/assessment of the familial cancer risk ($p < 0.001$). Many factors associated with an increase risk perception make sense from a neutral risk assessment perspective and are consistent with scientific

knowledge. However the impact of having a child on the risk perception is unexpected. It appears what when the threat (of cancer) could be apply to someone the threat in itself appears to be more prevalent/pregnant. Just like if trees makes the thunder more probable.

T2-I.2 Ellig J, Morrall J; jellig@gmu.edu
Mercatus Center George Mason University

THE QUALITY AND USE OF REGULATORY ANALYSIS: A NEW EVALUATION AND DATA SET

Congress and the executive branch have attempted to improve the quality of regulatory decisions by adopting laws and executive orders that require agencies to analyze benefits and costs of their potential decision options. President Obama recently requested that economists in federal agencies give “a dispassionate and analytical ‘second opinion’ on agency actions.” This paper assesses the quality and use of regulatory analysis accompanying every economically significant regulation proposed by executive branch regulatory agencies in 2008 and 2009. It considers all analysis relevant to the topics covered by Executive Order 12866 that appears in the Regulatory Impact Analysis document or elsewhere in the Federal Register notice that proposes the rule. Our research team used a six-point qualitative scale to evaluate each regulation on 12 criteria grouped into three categories: (1) Openness: How easily can a reasonably intelligent, interested citizen find the analysis, understand it, and verify the underlying assumptions and data? (2) Analysis: How well does the analysis define and measure the outcomes the regulation seeks to accomplish, define the systemic problem the regulation seeks to solve, identify and assess alternatives, and evaluate costs and benefits?; and (3) Use: How much did the analysis affect decisions in the proposed rule, and what provisions did the agency make for tracking the rule’s effectiveness in the future? With this project we hope to inspire agencies to produce better analysis and, as a consequence, better rules. In addition, this project has generated a database that scholars can use to answer a variety of other questions, such as “Did the Bush administration’s ‘midnight regulations’ have lower-quality analysis?” “How will the Obama administration’s forthcoming revisions to Executive Order 12866 affect the quality of regulatory analysis?” and “Are EPA’s economic analyses of higher quality than the other major regulatory agencies?”

W4-I.1 Engle M, Durkee S, Bailey M; engle.marilyn@epa.gov
US Environmental Protection Agency

THE UNEP GLOBAL MERCURY PROGRAM AND ITS RELEVANCE TO REDUCING MERCURY INHALATION PROBLEMS

Exposure to mercury can cause serious effects on human health around the world, particularly to nervous systems of developing fetuses and children. Mercury emissions from anthropogenic sources can travel and deposit locally, regionally and globally, resulting in exposures via ingestion of contaminated fish and also via inhala-

tion. The United Nations Environmental Program (UNEP), recognizing the global nature of the problem, initiated in 2003 a Global Mercury Program whose focus includes awareness raising and reducing uses and emissions of mercury globally. UNEP estimates that global man-made mercury emissions total 1900 metric tons/year (2005) and that the largest contributors are fossil fuel (primarily coal) combustion; artisanal and small scale gold mining (ASGM); and metals and cement production. Given the global scale of the mercury issue, international cooperation is essential. EPA has played a key role in helping UNEP develop an international Partnership framework for global coordination and is now participating in a UNEP-led negotiating process expected to lead to a global mercury binding instrument in 2013. The increasing amount of information relating to inhalation exposures in the ASGM context, including recent and historical data bases, can inform the UNEP process and efforts by EPA and others.

T4-C.3 Eosco GM; geosco@ou.edu
University of Kentucky

PICTURES MAY TELL IT ALL! USING DRAW-AND-TELL METHODOLOGY TO EXPLORE VISUAL DEPICTIONS OF HURRICANE UNCERTAINTY

Within the field of risk, there are a variety of contexts that require specialized communication research, such as, terrorism, nanotechnology, or plane crashes. Natural hazards, however, present unique challenges not only in how it is communicated, but how it is studied. Specifically, in the field of meteorology much of the observations used and information conveyed are in the form of visuals. Whether the weather brings thunder, snow, or hurricanes, the media bombards the public with a variety of visuals conveying risk and its associated uncertainty. Because this information is in the form of a visual, it is a challenge to research how the public makes sense of these visuals through the sole use of verbal communication. This study shows how the use of draw-and-tell methodology provides insight into how the public makes sense of hurricane track graphics, and their associated uncertainty. Specifically, the participant’s drawings of hurricane uncertainty provided forecasters with new ideas regarding shapes not commonly used in their current hurricane graphics. Discussion will include the challenges of using draw-and-tell methodology, but also its potential to further risk research on how to present uncertainty visually.

P.90 Evans AM, Stuart AL; evans.amandam@epa.gov
ASPH Fellow, US Environmental Protection Agency, National Center for Environmental Assessment, University of South Florida, College of Public Health

SPATIAL VARIATION OF AMBIENT FORMALDEHYDE AND ACETALDEHYDE: IMPLICATIONS FOR EXPOSURE ASSESSMENT

Formaldehyde and acetaldehyde are urban air toxics whose emissions from vehicles are expected to increase with the use of ethanol as a fuel additive. Understand-

ing of concentration variations over small spatial scales is needed for determining exposures and health effects due to mobile source air toxics. Here, Radiello® passive diffusive aldehyde samplers were used to measure ambient formaldehyde and acetaldehyde in a 10 km² sampling area in Hillsborough County, Florida from January 21 to 28, 2010. Samples were analyzed for aldehyde-DNPH derivatives via high performance liquid chromatography with ultraviolet detection. To evaluate passive sampler performance, concentrations were compared with values at a regulatory fixed-site monitor. Distribution statistics, concentration ratios, and spatial contours were calculated to investigate spatial variability. Mean aldehyde concentrations were 3.1 and 1.2 µg/m³ for formaldehyde and acetaldehyde, respectively. Observed spatial variation was small, with coefficients of variation of 13 and 23%, respectively. Similar spatial concentration trends were observed for both aldehydes measured. Results suggest that one sampler may be relatively representative of this sampling area, which is on the scale of a U.S. Census block group. Hence, this approach could be used for future studies of within-county spatial variability for exposure assessment or hot spot analyses.

M4-G.2 Evans MV; evans.marina@epa.gov

US Environmental Protection Agency

THE IMPORTANCE OF DATA EVALUATION FOR PBPK MODEL DEVELOPMENT AND RISK ASSESSMENT APPLICATION

PBPK models are useful in predicting the toxicologically relevant internal dose for environmental chemicals, and to extrapolate across species and different routes. For volatile organic compounds, PBPK models are usually calibrated using experimental data collected from kinetic experiments intended to establish the link between metabolism and proposed adverse health effects. When using experimental data designed for a different goal than model development, the modeler needs to ensure that original source data (plasma concentration) is appropriately converted to blood concentration for use in the PBPK modeling application. This talk will stress the importance of ensuring that data inputs are converted correctly, thus leading to an improved version of previous models. The process needed to ensure that current versions of PBPK models are included into risk assessments will be discussed. (This abstract does not reflect EPA policy).

P103 Evensen DTN; dte6@cornell.edu

Cornell University

IN THE EYE OF THE BEHOLDER: PERCEPTIONS OF WILDLIFE DISEASE RISKS

Both scientists and the public are increasingly identifying and reacting to risks associated with wildlife and vector-borne diseases. This trend presents wildlife managers, public health officials, and others with an unprecedented need to communicate effectively about disease risks. Communication design would benefit from an under-

standing of how people perceive and react to risks they associate with wildlife disease. Leading risk perception theorists generally agree that myriad factors influence individuals' beliefs about and responses to risks. The Social Amplification of Risk Framework (SARF), for example, suggests that cultural, social, and psychological factors work in concert to affect risk perceptions and reactions. The SARF identifies multiple factors, but is not as useful for explaining how perceptions and reactions are affected or identifying the process(es) by which the factors jointly operate. I studied how individuals perceived and responded to risks associated with wildlife and vector-borne diseases. I conducted case studies in four geographically- and culturally-diverse communities in and around US national parks. Intensive interviews with key informants at each site served as the primary means of data collection (total n = 106). Qualitative analysis of the interview data revealed twenty factors that affected risk perceptions and reactions across cases. Most factors had consistent effects across cases on the types and magnitudes of risk perceptions and reactions. I summarize these patterns and discuss ways in which entities seeking to evaluate risk perceptions and reactions could use this information. Finally, I place each of the identified factors under one of two broad themes: expectations and tangibility. I propose a framework based on these two themes as a parsimonious explanation of how several factors can work in concert to influence the types and magnitude of risk perceptions and reactions.

M4-I.5 Ezell BC, Behr JG; bezell@odu.edu

Old Dominion University

ADAPTIVE ADVERSARY: FACTORS & RELATIONSHIPS THAT LEAD TO TERRORIST DECISIONS

Currently, the U.S. Department of Homeland Security (DHS) elicits probabilistic judgments from the intelligence community on actions terrorists may take to attack the continental U.S. For example, how likely is the adversary to choose agent 'x' over agent 'y' or target 'a' over target 'b'? Eliciting these types of judgments is difficult and time consuming. The National Academies and others have suggested that a better approach may be to elicit information on adversary's preferences, perceptions, and capabilities and use this information to calculate probabilities of interest to DHS. Some terrorist groups are thinking about using weapons of mass destruction (WMD), each with its own values, perceptions of reality, and capabilities. This presentation details the findings on the factors & relationships among factors that lead to a terrorist decision to initiate an attack against the continental U.S. as well as target selection. To accomplish this, the Virginia Modeling, Analysis, and Simulation Center (VMASC) assembled international experts in WMD, adversary modeling, political science, terrorism, psychiatry, social sciences as well as experts from national laboratories, the Commonwealth of Virginia State Fusion Center, and Hampton Roads Emergency Management.

T4-D.1 Fanaselle W, Burkhardt W, Goswami B, Klonz K, Kulka M, Miliotis M, Dennis S; wendy.fanaselle@fda.hhs.gov
FDA-CFSAN

RISK PROFILE ON NOROVIRUS: DEVELOPING AN UNDERSTANDING OF THE TRANSMISSION PATHWAY AS A MEANS OF POTENTIAL CONTROL OPTIONS

Norovirus (NoV) is now recognized as the leading cause of foodborne illness in the United States and in the western world. Current estimates attribute more than 50% of all foodborne outbreaks of gastroenteritis in the U.S. to NoV. Norovirus usually results in a mild illness, but can be severely debilitating in immunocompromised individuals and has been estimated to cause as many fatalities internationally as Salmonella foodborne illness. Norovirus can be transmitted by air, oral-fecal, person-to-person, and can also be transmitted by consumption of contaminated seafood. However, most NoV foodborne outbreaks result from an infected food handler that is handling ready-to-eat foods, directly before consumption. These issues, together with the ease in transmission from infected food workers to ready-to-eat foods, and the difficulty in controlling this virus through normal cleaning procedures increase the importance of achieving a better understanding of effective controls for preventing the transmission of NoV. The U.S. Food and Drug Administration (FDA), Center for Food Safety and Applied Nutrition, (CFSAN) initiated a risk profile assessment as an initial step in managing risks associated with potential NoV foodborne illness. The risk profile summarizes the background information, the risks associated with transmission of the virus by food workers, and available risk management options in controlling NoV foodborne illness. This presentation will focus on the methods of NoV transmission and how this information can be utilized in developing effective control mechanisms for NoV foodborne illness.

T4-D.4 Fanaselle W, Niles R, McCoig A, Braddy J, Zhou T, Burnsteel C, Obasanjo O, Hooberman B, Luccioli S, Oryang D; david.oryang@fda.hhs.gov
US Food and Drug Administration

DRUG RESIDUES IN MILK AND MILK PRODUCTS RISK ASSESSMENT

Antibiotic and other drug therapy is allowed on the open market for the treatment of dairy cattle, without the oversight of a licensed veterinarian. Drugs that can only be obtained through a prescription for the treatment of humans and other drugs that are not approved for human drug therapy are freely available on the open market for farmers to administer to farm animals, including dairy cattle. Over the years, concern has been raised over the possibility of drug residues in dairy foods, such as fluid milk. This paper will describe the potential drug residue problem in milk and milk products and the approach utilized in analyzing this issue. The requirement to test milk and milk products for drug residues is limited to the Beta lactam

drugs and has not changed over the past twenty years. For this reason, the National Conference on Interstate Milk Shipments (NCIMS) Drug Residue Committee has requested that FDA perform a risk assessment on potential drug residues in milk and milk products produced in the United States to re-evaluate the National Drug Residue Milk Monitoring Program. The Drug Residues in Milk Risk Assessment Work Group consists of scientific and dairy experts from FDA, Center for Food Safety and Applied Nutrition (CFSAN) and Center for Veterinary Medicine (CVM) working together to develop a risk assessment on drug residues in milk and milk products. This paper presents the risk ranking semi quantitative approach that was developed to answer the risk management questions

T2-I.1 Farrow S, Viscusi WK; farrow@umbc.edu
UMBC, Vanderbilt University

PRINCIPLES AND STANDARDS FOR THE BENEFIT-COST ANALYSIS OF PUBLIC SAFETY

Risk is central to public safety and covers issues such as security, physical safety, health, natural hazards, and consumption of goods. Each of these areas of potential risk exposure has specific components such as crime, terrorism, food products, water, floods, and transportation accidents. Fundamental to each component is the element of risk of a bad outcome, including risks arising from nature as well as those that are the result of actions of people. Typically, decisions affect one's exposure to the risk as well as possibilities to alter the risk or its consequences, as through prevention, mitigation, or insurance. Risk and uncertainty are here used synonymously, based on a subjective risk framework where there may be few classical risks that are known with precision. Principles are designed to be few in number while there are both standards and "frontier" standards suggested for the benefit-cost analysis of public safety. These two types of standards are drawn from the literature and are meant to further evolve a professional discussion on improving consistency of methods and approach. Because elements of risk are important in areas outside of public safety, many of the same concerns surveyed here also may be relevant in other application areas. Essentially all applications of ex-ante or forecasting benefit-cost analysis involve many common issues of risk and uncertainty. While the focus of this paper excludes detailed discussions of applications, several examples from crime, terrorism, floods, and hazardous waste briefly illustrate the pertinent concepts.

M3-I.2 Faustman EM, Griffith WC; faustman@u.washington.edu
University of Washington

INS AND OUTS OF MODELING DEVELOPMENTAL TOXICITY DATA - WHERE ARE WE AT AND WHERE WOULD WE LIKE TO BE?

We have learned a tremendous amount about critical windows of development and the dynamics of the developmental process, however the challenge to modelers is how to effectively incorporate the myriad of new science within our dose-response

models. We have used biologically based dose-response modeling techniques to integrate across life stages to provide a framework for incorporating age-dependent kinetic and dynamic factors across levels of biological observations, endpoints and across species. Key biological events occur repeatedly throughout development and include cell replication, migration and differentiation. These processes occur at different times during development within specific organ regions (e.g. neocortex versus hippocampus) and can differ dramatically between species (i.e. events occur in utero versus postnatally). Thus, this biological information needs to inform our toxicokinetic and dynamic models. Evolutionary conservation of processes and pathways provides important context for interpreting results across platforms (in silico, in vitro, in vivo and across species) and both qualitative and quantitative parameters are needed in order to interpret normal as well as chemically perturbed signals during development. This presentation will present both the philosophical as well as practical lessons learned from over 15 years of research. The talk will identify critical missing modeling tools and resources needed for use response modeling of developmental toxicity in the 21st century. This work was supported by NIEHS grant numbers P30 ES07033, 5 P01 ES009601 and EPA grant number RD-83273301, RD-83170901.

W4-I.4 Fernandez LE, Habegger L, Peterson D, Brass B, Engle M; luisf@stanford.edu

Argonne National Laboratory

CHARACTERIZING AIRBORNE MERCURY RELEASES FROM GOLD SHOPS IN SOUTH AMERICA

Artisanal and small scale gold mining is responsible for one of the largest releases of mercury to the environment of any sector globally, releasing an estimated 400 metric tons of airborne elemental mercury each year. Found in over 70 countries, small scale retail gold buying and refining facilities (commonly referred to as “Gold Shops”) are responsible for a significant part of these airborne releases and are considered to be the single most important source of urban and semi-urban mercury emissions in the production of gold. However, detailed qualitative data needed for a clearer understanding of the contribution of gold shops to the global mercury cycle have been lacking. This paper describes one of the first comprehensive characterizations of airborne mercury emissions from ASGM gold shops. The results of a suite of studies examining the mercury aerosol and vapor releases of gold shops in 9 gold producing in Brazil and Peru are presented, as are data on the ambient mercury concentrations in these communities and qualitative estimates of human health risk from these gold shops to populations living adjacent to them.

W4-I.5 Fernandez LE, Habegger L, Bailey J, Engle M, Bailey M; luisf@stanford.edu

Argonne National Laboratory

REDUCING MERCURY RELEASES FROM ARTISANAL GOLD MINING: A LOW COST MERCURY EMISSION REDUCTION TECHNOLOGY FOR GOLD SHOPS

This paper describes a low cost, and simple-to-construct mercury control technology developed by the U.S. Environmental Protection Agency (USEPA) and Argonne National Laboratory (ANL) to reduce mercury emissions from gold shops. Gold Shops (small gold buying facilities) are responsible for a significant part of the airborne mercury releases (currently estimated to be 400 metric tons annually) from artisanal and small scale gold mining, and are also considered to be the single most important source of urban and semi-urban mercury emissions in the artisanal gold production, and effecting mainly poor populations in an estimated 70 countries. Few mercury control options exist in these areas due to the remoteness of these mining areas, high transport costs, and the prohibitive cost of industrial mercury control technologies. Using the novel approach of only using materials and technologies likely to be available in remote ASGM communities (e.g., a recycled 55-gallon drum, and a common arc welder), US EPA and ANL addresses the need for effective mercury reduction technologies that are appropriate for the challenging conditions in gold producing regions in the developing world. Results of in situ evaluation tests showing mercury reduction rates up to 80% using this new technology will be presented. We will also present projected mercury reductions and the estimated decreases in health risks of currently affected populations that would occur with wide-scale adoption of this technology in ASGM regions.

T2-C.4 Ferry JF, Wilson RS; ferry.41@buckeyemail.osu.edu

The Ohio State University

SOIL MANAGEMENT IN THE AGROECOSYSTEM: THE ROLE OF KNOWLEDGE, RISK PERCEPTION, AND SELF-EFFICACY

Agriculture has a pervasive and determinative influence on aquatic ecosystems due in part to individual soil management decisions. While previous research has made significant strides in understanding these decisions, it has failed to account for insights from behavioral decision science. People often argue that individual management decisions are driven exclusively by profit maximization; therefore, individuals should be as proactive as possible regarding how and when they apply nutrients because of the potential profit implications. However, profit maximization is not entirely descriptive of individual management decisions. We explore how knowledge, efficacy and perceived risk help explain an individual's propensity to deviate from the script of profit maximization. Specifically, we plan to analyze the relationship between perceived management risks (i.e. potential for yield loss), perceived water qual-

ity risk and perceived self-efficacy (the ability to gather and process information and the ability to impact water quality through individual management decisions). It is hypothesized that both increased risk perception and information gathering efficacy will increase knowledge, which in turn influences perceived management efficacy and action. However, we expect that risk perception will be most important in determining action (i.e., willingness to monitor nutrients in the soil and adjust management accordingly). Using a mental models approach, we first created an expert model of the agro-ecosystem from peer-reviewed literature. We then conducted interviews to assess an individual's mental model of the system (knowledge of the linkages between land use and water quality), while also asking targeted questions meant to elicit behavioral variables of interest. The degree to which the landowner's mental model reflects the expert model, and the extent to which that relationship can be predicted by the behavioral variables of interest will be discussed.

M2-H.3 Ferson S, Siegrist J, Grimson R; jacksie@eden.rutgers.edu

Applied Biomathematics

HOW DO YOU KNOW IF A CLUSTER IS REAL WHEN YOUR DATASET IS TINY?

Detecting outbreaks, structured clusters of events, is a common task in risk analysis, but traditional statistical tests are only valid for asymptotically large sample sizes. These tests are therefore not applicable to rare events in small populations such as on cruise ships, in prisons, in nursing homes, and in other institutions. Simulation studies have shown that the rate of false positives for traditional tests such as the chi-square test or the log-likelihood ratio can be much larger than their nominal rates when applied to small data sets. This results in declaring outbreaks more often than warranted, causing both undue alarm and unnecessary interventions. In some cases, however, traditional cluster tests can fail to detect clusters that can be shown by other methods to be statistically significant, and it is difficult to anticipate whether the traditional test will overestimate or underestimate the probability of clustering for a particular situation. We describe statistical methods that can be used to detect outbreaks of rare events in small delimited populations. These tests use combinatorial formulations that yield exact p-values and that cannot violate their nominal Type I error rates, so these tests are reliable regardless of the size of the data set. By design, these tests are sensitive to different aspects of clusters and provide information about both the existence of clustering and the processes that generated the clusters. Using these exact cluster statistics can help risk managers take defensible actions to prevent outbreaks and determine the causes of clusters. This work was supported by SBIR grant 5 R44 AI077146-03 from the National Institute of Allergy and Infectious Diseases of the National Institutes of Health.

M4-A.4 Finkel AM; afinkel@princeton.edu

Penn Program on Regulation, University of Pennsylvania Law School

WAITING FOR THE CAVALRY: THE ROLE OF RISK ASSESSORS IN AN ENLIGHTENED OCCUPATIONAL HEALTH POLICY

If we risk assessors truly believe that it is generally wise to try to address the “worst risks first,” then why do workers routinely face concentrations of toxic substances 4 to 6 orders of magnitude higher than are prevalent in the general environment? Different standards for “acceptable risk” can explain some of this disparity, but by no means all of it. Similarly, why does OSHA spend approximately 95 percent of its enforcement and outreach resources on safety hazards as opposed to health hazards, and why has it only developed exposure limits for nine substances in the thirty years since the Supreme Court set OSHA on the path of quantitative risk assessment? And to what extent is it cause or effect that SRA has published roughly eight times more papers on environmental health topics than on occupational health ones during its thirty years of engagement? This presentation will attempt to interest SRA members in the vast unfinished business of occupational risk management, focusing on exposure assessment and on regulatory law and policy. I will first present preliminary insights from a statistical analysis of the complete database (2.6 million observations over 31 years) of air sampling results generated by OSHA and recently obtained under a Freedom of Information Act lawsuit, emphasizing trends in exposures and the adequacy of the governmental response to them. I will then analyze the Benzene decision through the “half-full” lens of a former OSHA rulemaking official, pointing out areas where the Supreme Court offered highly precautionary interpretations of OSHA's authority to regulate health risks. Finally, I will critique several proposals for improving federal and state regulatory and non-regulatory capacity to solve occupational risk problems, including accelerated standard-setting, embrace of a HACCP-like model of industry self-regulation, and risk-based technology options analysis.

W4-F.4 Finley BL, Scott LLF, Galbraith DA; bfinley@chemrisk.com

ChemRisk, LLC

PLEURAL MESOTHELIOMA IN U.S. AUTO MECHANICS: EXPECTED VS. REPORTED CASES FROM 1975-2007

Until the 1980s, chrysotile asbestos was a component of automotive brakes. The current (2006) Occupational Safety and Health (OSHA) information bulletin for brake repair cites a single study of brake workers; this study concluded that the number of individual cases of pleural mesothelioma reported in auto mechanics indicates an asbestos-related risk for this occupation. However, the cited study did not compare the reported number of cases to an “expected” value. This represents a significant information gap, because pleural mesothelioma is known to occur in the general (non asbestos-exposed) population at a consistent rate and therefore it is ex-

pected that a number of “background” pleural mesotheliomas will occur in auto mechanics, even in the total absence of asbestos exposure. This analysis compares the number of pleural mesothelioma cases reported among U.S. auto mechanics from 1975-2007 to an expected value derived from labor statistics data and estimates of current + former workers. A total of 106 individual cases describing mesothelioma or malignant neoplasm of the pleura (MNP) in professional U.S. auto mechanics were found in the literature. Many had experienced significant amphibole exposure in other occupations, a well-established as the primary risk factor for mesothelioma in U.S. males. Using a “background” rate for pleural mesothelioma of 3 cases per million individuals per year, we estimated that at least 444 cases of non-asbestos related pleural mesothelioma would have occurred in current or former auto mechanics during this same time period. This estimate is biased low because mesothelioma rates are much higher in the older age groups that would be representative of most retired mechanics. Hence, our findings indicate that the number of pleural mesothelioma cases reported for professional automotive mechanics is actually far lower than the number of cases that would be expected to occur in the absence of any asbestos exposure.

P.23 Fitzpatrick JW, Gallagher K; fitzpatrick.julie@epa.gov
U.S. Environmental Protection Agency

U.S. ENVIRONMENTAL PROTECTION AGENCY HUMAN HEALTH RISK ASSESSMENT COLLOQUIUM

U.S. EPA has scheduled a Human Health Risk Assessment Colloquium for October 2010. The goal of the Colloquium being to take stock of the Agency’s work toward advancing risk assessment while focusing on the recommendations presented in recent NRC reports and the Administrator’s priorities. The Colloquium will include discussions of the Agency response and proposed follow-up to recommendations made by the NRC in Science and Decisions: Advancing Risk Assessment; Phthalates and Cumulative Risk: The Tasks Ahead; and Toxicity Testing in the 21st Century. The EPA Administrator’s priorities and key recommendations from other external advisory reports will also be considered by the participants from across the Agency. This poster will present the key points of the Colloquium discussions on advancing the science of human health risk assessment.

M2-B.1 Flari V, Neslo R, Chaudhry Q, Cooke R; villie.flari@fera.gsi.gov.uk
Food and Environment Research Agency, UK, University of Delft, the Netherlands Resources for the future

MULTI CRITERIA DECISION MAKING MODEL BASED ON PROBABILISTIC INVERSION: APPLICATION TO RISK ASSESSMENT OF NANOTECHNOLOGY-ENABLED FOOD PRODUCTS

Known and projected applications of nanotechnology for the food sector, so far, fall into 4 categories (Chaudhry et al., 2008). Concomitant with growing industry interest in these technologies & products are concerns about safety and relevant regu-

latory issues. Currently these are difficult to address due to the lack of knowledge of possible interactions of nanomaterials at the molecular and/or physiological level and their effects on human health either directly or indirectly. This level of uncertainty requires input of expert judgment, and it is expected that experts’ opinions will vary. The issue in question then becomes: how to capture experts’ current knowledge and uncertainties & to understand how experts use their knowledge when thinking about possible risk of nanotechnology-enabled food products. Our approach employs a multi criteria decision making model based on probabilistic inversion (PI) (Teck et al., 2010); it enables us to model experts’ judgments regarding safety of such products in terms of scores on 10 criteria. Study of the multi criteria literature did not turn up any method for obtaining true out-of-sample validation for such models. Instead of directly assessing weights for criteria our approach requires experts to rank a number of scenarios differing with respect to values on the criteria. PI is then used to obtain a distribution over criteria weights which best reproduces the observed distribution of expert rankings. Out of sample validation is achieved in 2 ways: (a) a portion of the rankings is excluded from the fitting; these rankings are then predicted by the model fitted on the remaining rankings; (b) a partially different set of experts generate new scenarios, using the same criteria and rank these; their ranks are compared with ranks predicted by the model. The degree of validation in each method was less than perfect, but very substantial. This paper describes the PI method, the expert exercise and the results of both methods of validation.

T2-F.4 Flari V, Maule J, Hart A; villie.flari@fera.gsi.gov.uk
Food and Environment Research Agency, UK; University of Leeds, UK

COMMUNICATING SCIENTIFIC UNCERTAINTIES TO POLICY MAKERS AND DECISION MAKERS: A TWO-WAY ROAD

Scientific knowledge is a pillar for making regulatory decisions or decisions during emergencies in the areas of environment and public health. Nevertheless, scientific knowledge is never complete, particularly so in emergency situations; thus, it is expected that, at the time risk assessments are due, scientists should communicate as well what is not known to policy and decision makers. Communicating scientific uncertainties as transparently as possible, becomes important because by stating what we do not know we give the opportunity to the decision makers to recognize the fictional nature of conceptual, value or probabilistic models that attempt to represent the real world, and to acknowledge the possibilities of different “what if” scenarios to become true. The research described in this paper aimed to explore the effectiveness of a number of ways of communicating scientific uncertainties to policy/decision makers. Two challenges are tightly weaved in such a concept: (1) low number of participants as the research required input from policy makers/decision makers who more than often are heavily committed; (2) qualitative nature of data recorded. To address these challenges we opted to follow a structured approach to record partici-

pants' views. We planned research objectives as structured exercises; the latter were designed to capture both individual opinions (via individual workbooks) and views expressed in group discussions (via audio recorded sessions). We employed 2 case studies (CS): (1) CS A employed outputs of models of elicited expert opinion on estimates and ranges associated of the average annual cost of exotic animal diseases and average total annual cost; (2) CS B employed scientific outputs from a project on Bayesian approaches to microbial risk assessment; outputs were presented in the context of a hypothetical scenario (i.e. possible contamination of pasteurised single herd milk from a fictional farm, with Vero-cytotoxic *Escherichia coli* (VTEC 0157)).

M2-C.3 Fleishman LA, Bruine de Bruin W, Morgan MG; lauren@cmu.edu
Carnegie Mellon University

INFORMED PUBLIC PREFERENCES FOR ELECTRICITY PORTFOLIOS WITH CCS AND OTHER LOW-CARBON TECHNOLOGIES

Public perceptions of carbon capture and sequestration (CCS) and other low-carbon electricity generating technologies could affect the feasibility of their widespread deployment. Many of these technologies are unknown or misunderstood by members of the general public, hampering their ability to make informed decisions about whether or not to support specific technologies. For this study, we developed comparative, technically accurate yet understandable, information about CCS and other low-carbon technologies using established risk communication methods (e.g., Florig et al. 2001, Morgan et al. 2002). We then asked a diverse sample of 60 participants recruited from community groups in Pittsburgh, PA to rank ten technologies (e.g., coal with CCS, natural gas, nuclear, various renewables, and energy efficiency), and seven realistic low-carbon portfolios composed of these technologies, after receiving comprehensive and carefully balanced materials that explained the costs, benefits and limitations of each technology. The ranking exercise asked participants to assume that the U.S. Congress had mandated a reduction in CO₂ emissions from power plants to be built in the future. Overall, rankings suggest that participants favored energy efficiency, followed by nuclear, integrated gasification combined-cycle coal (IGCC) with CCS and wind. The most preferred portfolio also included a diverse mix of these technologies. We conclude that these informed members of the general public preferred diverse portfolios that contained CCS and nuclear over the presented alternatives once they fully understood the benefits, cost and limitations of each. The materials and approach developed for this study may also have value in educating members of the general public about the challenges of achieving a low-carbon energy future.

W2-D.3 Forshee RA, Cowan E, Hoffman H; richard.forshee@fda.hhs.gov
US Food and Drug Administration

ESTIMATING THE RISKS AND BENEFITS OF HOME-USE HIV TEST KITS

Background: Home-use HIV test kits can potentially identify many HIV-positive individuals who are unaware of their status, but they may also produce a large number of incorrect test results because of user error. We have developed an analytic tool to estimate the public health benefits and risks of a home-use HIV test kit. Methods: A Monte Carlo computer simulation was developed to estimate the number true positive, true negative, false positive, false negative, and test failure results if a home-use HIV test kit was approved for use in the United States. The model considered four subpopulations: low risk heterosexuals, high risk heterosexuals, men who have had sex with men, and injectable drug users. Subpopulation specific inputs were size of the subpopulation, percent of the subpopulation that is untested, percent of untested persons who are HIV positive, and percent of untested persons who would use a home-use HIV test kit. The ratio of true positive to false negative, true negative to false positive, and true positive to false positive were estimated to facilitate consideration of public health tradeoffs. Results: The model estimated that 111,000 HIV positive individuals and 7,200,000 HIV negative individuals would use a home-use HIV test kit in the US. Because of the relatively large number of HIV negative individuals predicted to use the test, the ratio of true positive to false positive test results is strongly related to the specificity of the test. Conclusions: The computer simulation provides decision-makers a tool that can model the likely public health impact of a home-use HIV test kit across a range of test characteristics. Value judgments are required to assess the public health impact of each test outcome; for example, one true positive is not directly comparable to one false positive. However, the computer simulation tool facilitates judgments about acceptable tradeoffs.

W2-C.4 Frederick RJ, Ridley CE, Shaw DM, LeDuc SD; frederick.bob@epa.gov
US Environmental Protection Agency, Washington, DC

PROBLEM FORMULATION FOR ENVIRONMENTAL RISK ASSESSMENT OF FEEDSTOCK CULTIVATION NECESSARY TO MEET NATIONAL BIOFUEL PRODUCTION TARGETS

With the Energy Independence and Security Act of 2007 (EISA), the United States Congress established annual targets for the production of biofuels increasing to 36 billion gallons per year (bg/yr) by 2022. Approximately 12 bg/yr of ethanol are currently being produced in the United States commercially, more than 90% of which is derived from corn starch. Over the next twelve years, however, cellulosic conversion technologies are expected to mature and nearly 50% of the EISA target for 2022 will be met using feedstocks such as corn stover, perennial grass, and woody biomass. The USEPA has been asked to evaluate the potential environmental impacts

that might be associated with the large scale production of biomass feedstocks and to provide Congress with triennial reports. This presentation describes the development of a problem formulation that will lead to systematic assessment of the environmental risks associated with increased biofuel production. It anticipates what will be necessary to 1) identify appropriate assessment endpoints, 2) quantify environmental risks, and 3) point to methods for monitoring direct and indirect environmental impacts. Using a common risk assessment paradigm, a series of conceptual models have been developed for five different biofuel feedstocks and for two categories of biofuel (ethanol and diesel). The preliminary identification of the potential impacts and an assessment of their likelihood to occur are considered in the problem formulation. This was done using a life cycle analysis approach to create a series of scenarios at a regional scale and then comparing possible environmental impacts and their likelihood. Along with the development of robust assessment tools, a regional evaluation of feedstock choices, the establishment of cost effective environmental monitoring programs, and the implementation of risk management options will help to ensure the sustainability of biofuel production.

W4-B.3 Freudenburg WR, Collins MB; freudenburg@es.ucsb.edu

University of California, Santa Barbara

PUBLIC KNOWLEDGE, RECREANCY, AND NANOTECHNOLOGY: A CALL FOR EMPIRICAL RESEARCH

As reported by other papers in this symposium, research to date has shown such low levels of public awareness or concern about nanotechnology that roughly half of the U.S. public reports knowing “nothing at all” about it. Those who are willing to express opinions are likely to see the benefits outweighing risks, but the plurality of survey respondents express no opinions. The low levels of awareness make it unwise to draw solid conclusions, at present, but also suggest the potential value of testing the knowledge perspective versus the recreancy perspective. In technological controversies of the past, the knowledge perspective blamed public opposition on low levels of technical knowledge, arguing that “public education” would lead to greater risk acceptability. The recreancy perspective, which builds more directly on classic social theories, argues that the knowledge perspective reveals a fundamental misunderstanding about what it means to live in a technologically advanced society. Collectively, we know far more than did our great-great grandparents, but individually, we know far less than did our ancestors about the technologies on which we depend, pointing to the importance of being able to trust the specialists and organizations that we rely upon to manage those technologies. The recreancy perspective has provided a far better “fit” to past controversies, but the current low level of public knowledge about nanotechnologies offers an important opportunity for testing these two competing perspectives against the emerging evidence. The knowledge perspective predicts that, as information about nanotechnology continues to build, public support should grow as well. The recreancy perspective calls for little change

in public knowledge or opinion until or unless unfortunate events take place that send the public a “signal” that raises questions about those who bear responsibility for managing the technology safely. Further research, clearly, is required.

W3-E.2 Freudenburg WR, Gramling RB; freudenburg@es.ucsb.edu

University of California, Santa Barbara

CUTTING-EDGE TECHNOLOGIES AND BLUNT- INSTRUMENT RESPONSES: EARLY LESSONS FROM THE BLOWOUT OF THE BP/ DEEPWATER HORROR ZONE

Cutting-edge technologies are now so expensive that some expect free-market economic pressures to assure safe operations, even in the absence of vigorous regulations and enforcement. The BP/Deepwater Horizon blowout in the Gulf of Mexico, however, clearly calls into question the credibility of such expectations. An alternative expectation that was developed in the aftermath of the Exxon Valdez oil spill predicts an Atrophy of Vigilance: long periods of apparently safe operation will lead to the temptation to cut corners, in ways that jeopardize safety. After an accident, a sudden burst of vigilance can be expected - from industrial organizations, workers, and regulators - but if time passes without further accidents, the atrophy of vigilance can set in again, continuing until the next serious accident. Several years before the Exxon Valdez, the mining disaster at Buffalo Creek, WV, pointed to another concept that is rarely discussed at SRA meetings - the Technological Peter Principle, or the tendency to depend on an apparently useful technology, up to and beyond the point where we are competent to control it. The BP blowout in the Gulf of Mexico appears to illustrate both of these concepts. In actions leading up to the blow-out, the atrophy of vigilance was visible both in the agency regulating offshore oil (the U.S. Minerals Management Service) and in the actions of BP and its contractors, including corner-cutting such as prematurely withdrawing the heavy drilling mud from the well and failing to make sure a key safety device had a working battery. The aftermath of the spill, similarly, illustrates the Technological Peter Principle: Our ability to do damage to the environment has clearly surpassed our ability to “undo” the same damage. Based on preliminary evidence, it appears that we need a more realistic approach to such “impossible” events, with an emphasis on improved attention to shortcuts and other potential precursors, as well as a renewed emphasis on developing improved response capabilities in the future.

W3-B.2 Friedman SM, Egolf BP; smf6@lehigh.edu

Lehigh University

U.S. NEWSPAPER COVERAGE OF NANOTECHNOLOGY RISK REGULATION ISSUES

During the past decade, there has been a great deal of U.S. governmental activity regarding nanotechnology. Since 2000, the government has invested \$12 billion in nanotechnology efforts through National Nanotechnology Initiative (NNI) and 25

federal agencies. Legislation was introduced into Congress to reauthorize the 21st Century Nanotechnology Research and Development Act of 2003 and hearings were held, where concerns were voiced about research on and regulation of environmental, safety and health issues. A 2008 review of the NNI by the National Research Council found serious weaknesses in the government's plan for research on the health and environmental risks posed by nanomaterials. From a risk regulatory perspective, several federal agencies held open meetings, developed voluntary monitoring programs and tried to use existing federal law in regulation efforts. While the mass media would not report on all of these activities, given their frequency, the amount of funding involved, and the potential impact of regulation on both the benefits and risks of nanotechnology, some risk regulation issues should have been covered. This presentation will explore newspaper coverage of U.S. government activities and regulation related to health and environmental risk issues as the third major aspect of our longitudinal study of U.S. and U.K. newspaper and wire service coverage from 2000 to 2009. Besides presenting content analysis data, it will include information from interviews done with key government officials and non-government observers. In addition, the presentation will discuss measures of U.S. and U.K. newspaper coverage of nanotechnology's health and environmental risks in 2009, continuing to document the lack of nanotechnology risk coverage in both countries.

M2-F.2 Frith J; jhfrith@ncsu.edu

North Carolina State University

THE COMMUNICATION OF LOCATED RISKS: MOBILE TECHNOLOGIES AS EMERGING COMMUNICATION CHANNELS

Location has become a major piece of new mobile applications. These applications are called Location Based Services (LBSs), which are services accessed through smart phones that use GPS coordinates to provide place-specific information. There are a wide range of LBSs, and this presentation will examine one of the most popular: Foursquare. Foursquare is a service that maps the locations of one's friends and allows users to leave geo-coded messages that can only be accessed in specific places. Foursquare has become one of the exemplars of the next generation of mobile Internet services. This presentation will use Foursquare as a case study to examine this new generation of LBS from a risk communication perspective. The presentation will examine Foursquare from two distinct approaches. The first approach analyzes how Foursquare's developers communicate privacy risks to the general public. Privacy has been the main issue slowing the development of LBSs over the last decade, and developers have used myriad techniques to communicate the privacy risks of LBSs to the general public. The second prong of the case study will examine how planners have used LBSs-Foursquare and Twitter in particular-as platforms for communicating risk information. Because these services provide place specific information and alerts, they can be used to alert users of specific hazards. For example, within moments of the evacuation announcement of Times Square in May,

the Wall Street Journal checked into Foursquare with an alert that Times Square was being evacuated. Foursquare users checking into Times Square were alerted of the evacuation. Twitter's location features have also been highlighted as a major tool for the next generation of hazard communication. This presentation will examine these services from these two distinct perspectives to understand how the privacy risks are communicated and how the services are used to communicate risk.

P.79 Fujinaga A, Fujikawa Y, Hiraki T, Nakatsubo R; fujinaga@ipc.osaka-pct.ac.jp

Osaka Prefectural College of Technology

PREDICTION OF ASBESTOS CONCENTRATIONS IN AIR BASED ON A DROP TEST AND COST-BENEFIT ANALYSIS ON COUNTERMEASURES FOR HEALTH RISK

Health risk of asbestos became one of the top environmental concerns in Japan after a number of malignant mesothelioma cases were found among residents around an asbestos products factory in 2005. This study investigates health risk of removal and disposal of sprayed asbestos based on drop tests of asbestos - containing materials. Effectiveness and cost-benefit of three disposal options (Case 1: mechanical demolition and disposal in a landfill, Case 2: hand demolition and disposal in a landfill, Case 3: hand demolition and vitrification treatment) were examined by predicting air concentrations of asbestos in order to reduce the risk, and also cost-benefit for countermeasures was analyzed. The maximum asbestos emission rate of cement solidification was 310 f/s (total number of fibers (4027 f) / sampling time (13 seconds)) and the asbestos concentration in the air at the emission point was 315 f/L. Ambient asbestos concentrations at 10 to 200 m from the emission point were calculated by an air diffusion model (plume model), and health risk at 10m from the emission point was below 10⁻⁵, i.e., an acceptable level of risk. The total cost of Case 3 was twice that of Case 2. If vitrified solid could be recycled in Case 3, the cost of Case 3 was equal to Case 2. The total cost of Case 3 was 255 million US\$ higher than that of Case 2, and lead to the 2.0x10⁻⁶ reduction in lifetime risk. This result is very useful for risk communication among residents, government, and owners of asbestos containing materials or buildings, and also useful for planning disposal of asbestos waste in future.

W1-A.2 Gaborek BJ; bonnie.j.gaborek@usa.dupont.com

EI DuPont de Nemours and Company (DuPont)

ADDING EXPOSURE INTO THE RISK EQUATION TO SUBTRACT OUT HAZARD

With the advent of the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) regulation, exposure assessment became as important as hazard (toxicity) assessment in determining the public health risks associated with new and existing chemicals in the European Union (EU) marketplace. For each sub-

stance manufactured in or imported into the EU at a volume of ten or more tons per year, REACH mandates comparisons of hazard endpoints with exposure estimates in a risk assessment (Chemical Safety Report) for the entire life-cycle of that substance. REACH was designed not only to ensure a high level of protection to human health and to the environment, but also to limit the need for additional animal testing. Consequently, if the risk assessment can support that exposure is “absent, unlikely, not relevant or not significant,” the registrant may qualify for a reduced collection or generation of intrinsic property information. This process, whereby an exposure assessment supports waiving of particular testing requirements, is referred to in REACH guidance as exposure-based adaptation (EBA). Especially at high tonnage volumes, a vast array of intrinsic property information, to include physicochemical testing and testing to determine human and environmental toxicity endpoints, is required for completion of the registration dossier. This presentation briefly discusses the role of hazard and exposure in REACH risk assessment. The presentation then focuses on EBA with specific recommendations of what features to retain, eliminate, or enhance if a similar process is employed within the United States under modernized chemical management policy

M2-E.4 Gao HO; hg55@cornell.edu

Cornell University

CAN WE GET THERE WITH CLEANER AIR? TEMPORAL AND SPATIAL STATISTICAL ANALYSES OF URBAN TRANSPORTATION ACTIVITIES AND OZONE POLLUTION

Ozone pollution control requires controlling emissions of ozone precursor gases [e.g., volatile organic compounds (VOC) and nitrogen oxides (NO_x)]. VOC and NO_x emissions come primarily from anthropogenic emissions, to which transportation sources are the single major contributor. In 2007, highway and off-highway vehicles contributed 47% of anthropogenic VOC emissions and 55% of total NO_x emissions nationally. Consequently, controlling transportation emissions is considered crucial to ozone reduction and fine particulate matter (PM_{2.5}) control. In this talk, we will examine temporally and spatially resolved transportation emissions inventories for health impact assessment and the whole spectra of the nexus between transportation and air quality planning. Successful ozone control strategies require an improved understanding of transportation emission activities and ozone formation/scavenging dynamics, which are reflected in the variability associated with diurnal ozone cycles. This study contributes to our understanding of ozone dynamics by conducting functional data analysis (FDA) of daily ozone and NO_x curves. Functional analysis of variance (FANOVA) is used to statistically examine day of week effects on ozone/NO_x cycles, particularly the ozone weekend effect (OWE). The OWE is then directly linked to identifying efficient ozone control strategies by statistically examining weekly patterns in the timing, magnitude and fleet mix of

traffic activities, the dominant sources to ozone precursors emissions. We conduct nonparametric factorial analyses of light-duty vehicle (LDV) and heavy-duty truck (HDT) volumes observed at 27 weigh-in-motion (WIM) traffic monitoring stations in southern CA to examine the implications of their weekly and spatial patterns for the OWE. Our results will help in the development of State Implementation Plans (SIP), evaluation of traffic control measures (TCMs), and modeling of transportation and environment systems interactions.

W4-C.5 García S, Muñoz F; s.garcia64@uniandes.edu.co

Universidad de los Andes

AN EVALUATION OF DENSER THAN AIR DISPERSION MODELS

The modeling of denser than air dispersion models constitutes an important aspect of risk analysis in chemical industries, considering the evaluation of production systems, storage and the transport of hazardous materials. Many dispersion models have been developed for lighter than air materials, but these are not suitable for the modeling and simulation of the dispersion of gases such as ammonia, chlorine or propane, which emphasizes the need to study particular models for this type of substances. Two different programs based on the Britter-McQuaid and SLAB models were created, using numerical methods and setting specific parameters to generate scenarios of denser than air gas dispersion. Once the programs were set, a typical scenario was constructed in both of the programs. The obtained results were compared with the results obtained utilizing FLACS, a popular CFD model among the petrochemical industry. FLACS has been extensively validated for the dispersion of denser than air gases in urban and industrial areas, which is why given a proper use of the tool, appropriate and accurate results predicting gas dispersion may be obtained and used to validate the developed software. It was found that even though these three computational tools were based on different models, they all provide an estimation of the consequences of an event simulated with the same characteristics.

W1-B.3 Gardberg J, Bittner C; jgardberg@utah.gov

Utah Division of Water Quality

MERCURY IN GREAT SALT LAKE BIOTA

Several studies have recently been completed that measured the concentrations of mercury (Hg) in Great Salt Lake (GSL) biota. These studies have focused on birds and their food items because the birds are in the top trophic level of the GSL food web and the tendency of Hg to bioaccumulate. Hg was measured in the tissue, blood, organs, and eggs of aquatic-dependent birds. Frank toxic effects were not observed in any of the studies. Hg was also measured in brine shrimp and brine flies, a critical food source for aquatic-dependent birds at GSL. Seasonal variations in Hg concentration in brine shrimp were investigated. These results will be summarized with a comparison to literature toxicity benchmarks.

M4-E.1 Garvey PR; pgarvey@mitre.org

The MITRE Corporation

MODELING AND MEASURING NETWORK TOLERANCE BY FUNCTIONAL DEPENDENCY NETWORK ANALYSIS (FDNA)

Critical considerations in assessing system operational effectiveness are identifying, representing, and measuring dependencies between entities (e.g., programs, functions, technologies) necessary for its successful operation. The importance of understanding entity relationships is many-fold. Primary is enabling the study of ripple effects that degraded performance in one entity has on the performance of other dependent entities across a relationship network that characterizes a system. The ability of a networked system to absorb the effects of nodal degradation while maintaining an acceptable level of operational effectiveness is known in FDNA as network tolerance. Modeling and measuring the degradation tolerance of a network is a major consideration in planning, design, and investment decisions. One way to approach this topic is from the perspective of graph theory. Graph theory offers a visual representation of complex dependencies between entities and enables the design of formalisms that measure and trace the effectiveness of these relationships as they affect many parts and paths in a graph. Likewise, a system can be represented as a network of systems, infrastructures, or organizational entities expressed as nodes on a graph that depict direction, strength, and criticality of feeder-receiver dependency relationships. With this, algorithms can be designed to address questions such as the following: What is the effect on the ability of a mission to operate effectively if one or more entities or feeder-receiver chains degrade, fail, or are eliminated due to adverse events or situations? How much operational degradation occurs and does it breach the system's minimum acceptable level of performance? An approach to address these and related questions is called Functional Dependency Network Analysis (FDNA). FDNA is a methodology that enables planners to measure the ripple effects of degraded operability in one or more entities or feeder-receiver chains on system capabilities, due to the potential realization of adverse events.

M4-I.1 Gauthier Y, Shaw RHAD; yvan.gauthier@forces.gc.ca

Defence Research and Development Canada

A RISK-BASED APPROACH TO THE OPTIMIZATION OF INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE ACTIVITIES

Optimizing the selection, allocation and employment of intelligence, surveillance and reconnaissance (ISR) assets is a recurrent and challenging issue for defence and security organizations. Decisions are often exclusively based on vulnerability measures such as detection, identification or tracking performance. Although these measures may adequately describe systems' capabilities, they do not provide a complete picture of the risk posed by various threats and the potential consequences if authorities cannot react to these threats in a timely and appropriate fashion. This

paper proposes an approach that considers the triad of threat, vulnerability and consequence for comparing the risks associated with various scenarios. Threat assessments are based on a combination of intelligence and historical analysis. Vulnerability assessments leverage multiple measures of ISR performance derived from operational data. Consequence assessments have multiple dimensions (e.g., economic, social, environmental) and are obtained through modelling or expert judgement. These threat, vulnerability and consequence assessments are then combined to generate a risk score, which forms the basis of an objective function used for optimizing ISR activities. An example of how this approach is being developed and applied to improving Canadian Forces' maritime ISR operations is presented. The same approach could also be applied to improving other aspects of domestic security operations.

M3-I.3 Gentry PR; rgentry@environcorp.com

ENVIRON International Corporation

USE OF PBPK MODELING TO CHARACTERIZE DOSE IN THE MODELING OF DEVELOPMENTAL TOXICITY DATA

Physiologically based pharmacokinetic models (PBPK) are an important tool increasingly used in chemical risk assessments to help make key pharmacokinetic factors in the process more explicit, and provide a means for estimating the significance of these factors in the final risk estimates. In conducting dose-response modeling of developmental toxicity data, these models can be used to provide a more appropriate estimate of exposure or dose to the developing offspring. Estimation of exposure or dose during development is complex, because during the perinatal period, exposure to the fetus is dependent on placental transfer, while for the neonate significant exposure may occur via ingestion of breast milk. It is complicated by the fact that both maternal and fetal exposure must be considered together. An added dimension when considering the relevant internal dose metric for perinatal exposure is the timing of that exposure relative to the stage of development of the potential target organ or system. Multiple case studies will be presented in which PBPK models were used to characterize exposure to the developing offspring during the critical period of exposure (from a pharmacokinetic perspective) of development. The incorporation of these dose metrics into dose-response modeling to determine potentially safe exposure levels from developmental toxicity data will also be presented.

W2-B.4 Gernand JM, Casman EA; jgernand@andrew.cmu.edu

Carnegie Mellon University

IDENTIFYING INFORMATION-RICH CHARACTERIZATION ATTRIBUTES FOR NANOMATERIAL TOXICITY RISK ASSESSMENT

Given that nanomaterials behave in unique ways as compared to bulk material or solutions of the same chemical, new risk models that incorporate the relevant nano-scale properties are required to anticipate those risks. Despite efforts such as MinChar, which outlines broad categories of important nano-specific characteristics,

debate continues on the most important specific measures and tests that should be required across all nanomaterial risk studies. This study seeks to provide specific recommendations for minimum nanomaterial characterization with quantitative measures of information value. Data from in vivo toxicology experiments on a diverse set of nanomaterials are analyzed using statistical classification trees (a machine learning technique) to determine which measured attributes hold the most information about the toxicity outcome. The information value of each measured attribute is ranked based on the hierarchy of its predictive value across multiple toxicity outcomes and multiple nanomaterial chemistries and morphologies. Sensitivity testing is conducted for missing characterization values, weighting factors, and information-value aggregation procedures, revealing which attributes can be identified as information-rich with a high confidence. This method allows the classification of nanomaterial attributes into three categories with respect to toxicity: information-rich, information-poor, and uncharacterized (those with insufficient experimental data).

W4-A.5 Gerst MD, Howarth RB, Borsuk ME; mark.borsuk@dartmouth.edu
Dartmouth College

RARE DISASTERS, RISK ATTITUDES, AND AMBIGUITY IN THE ECONOMIC ANALYSIS OF CLIMATE POLICY

The accommodation of rare disasters in macrofinancial analysis has been shown to reveal societal risk preferences that are substantially different from those commonly employed in economic models of climate change. We incorporate the rare-disasters framework into a stochastic integrated assessment model to assess the combined effect of empirically supported risk preferences and fat-tailed risk exposure on the optimal choice of climate policy. Results reveal that deep cuts in greenhouse gas emissions are robustly consistent with maximization of social welfare unless society has relatively weak aversion to risk—a situation strongly inconsistent with equity data. In comparison to the extant climate policy literature, this finding is novel in suggesting that aggressive emissions reductions are justified without appeals to a low discount rate, fat-tailed uncertainty, or a steeply convex damage function. A challenge in our analysis is that it is difficult to pin down the relative likelihood of rare disasters, both historically and under future climate change. This introduces ambiguity into our analysis, requiring the consideration of preferences for ambiguity in addition to risk. Assuming ambiguity aversion, we foresee two competing forces which have the ability to change our current results. However, our current working hypothesis is that consideration of ambiguity aversion will lead to a preference for similar or lower stabilization scenarios than the 450 ppm scenario identified by our results to date.

W1-I.2 Giesecke R, Burns W, Barrett T, Bayrak E, Rose A; adam.rose@usce.edu
University of Southern California

MODELING THE ECONOMY-WIDE CONSEQUENCES OF BEHAVIORAL RESPONSES TO TERRORISM EVENTS

Using a large-scale CGE model, we investigate the short-run and long-run regional economic consequences of a catastrophic event - attack via chlorine release - centered on the downtown Los Angeles area. We distinguish two main routes via which such an event might affect regional economic activity: i) reduction in effective resource supply (the resource loss effect) and ii) shifts in the perceptions of economic agents (the behavioral effect). Broadly, the resource loss effect relates to the physical destructiveness of the event, while the behavioral effect relates to how changes in fear and risk perception on the part of firms, households and government affect their economic actions. Both affect the size of the regional economy. Chlorine release causes little direct capital damage, but may cause casualties numbering in the thousands. As such, the resource loss effect of such an event could be substantial. Another potential route for resource loss, business interruption, is likely to be relatively unimportant, since decontamination would likely be rapid, with surfaces affected by chlorine quickly re-opened to the public after decontamination. The speed, effectiveness and low cost of chlorine clean-up also mitigate behavioral effects. Changes in fear and risk perception following a terrorist attack have the potential to increase the supply cost of resources to the affected region, while simultaneously reducing demand for goods produced in the region. In the case of intentional chlorine release, such perception effects are not likely to be long lasting, at least not relative to attack scenarios that generate lingering uncertainty, such as radiological dispersal device detonation. We conclude the paper with a discussion of implications for policy to mitigate economic losses arising from attack via chlorine release.

P.113 Gilmore EA, Lave LB
Engineering and Public Policy & Tepper School of Business, Carnegie Mellon University

COMPARING RESALE PRICES AND TOTAL COST OF OWNERSHIP FOR GASOLINE, HYBRID AND DIESEL PASSENGER CARS AND TRUCKS

Turbocharged direct injection (TDI) diesel and hybridized electric gasoline (HEV) vehicles provide higher fuel economy, but are more expensive to manufacture and sell at higher prices than conventional gasoline vehicles. A rational owner will expect to recover this price premium in fuel savings and intangibles (e.g. torque, vehicle lifetime, etc...). Since most owners hold vehicles for three to five years, the resale value must also reflect the price premium. Here, we employ prices from used vehicle auctions to investigate depreciation mechanisms and to compare the total of cost of ownership for TDI and HEV vehicles and paired conventional vehicles. We find that accumulated odometer mileage accounts for a significant portion of the auction

price with monthly variability from external shocks in 2008 and 2009. For passenger cars, we find that vehicles with higher fuel economy retain more value than the paired conventional vehicle during periods of higher fuel costs. By contrast, the trucks lose value. We also find that the difference in resale prices between paired vehicles exceeds the expected discounted future fuel costs. We suggest that other attributes such as performance or prestige account for this difference. Regardless of the mechanism, the higher resale prices justify the higher capital cost for the TDI and HEV passenger cars and for larger TDI trucks on a total cost of ownership basis.

T4-I.1 Gilmour L, Kolasky RP; lillian.gilmour@hq.dhs.gov

Department of Homeland Security

WORDS MATTER: DEVELOPING A HOMELAND SECURITY RISK LEXICON

Despite the many challenges in developing a lexicon of terminology for an organization, the value of having a common lexicon far outweighs the effort required to develop it. Amongst the many challenges, the Department of Homeland Security (DHS) addressed a multi-layered review process, diverse and complex mission areas, and sometimes incompatible usage of risk terminology. The Office of Risk Management and Analysis was successful in collaboratively working with multiple Components within the Department in achieving consensus for a risk lexicon that included both risk management terms and risk analytical terms. We will describe the process of leading a major revision to a formal risk lexicon for DHS and the broader homeland security enterprise, and then share the lessons learned from inception to publication. We will discuss lexicon technical issues, such as identifying and harmonizing risk terminology, balancing between heterogeneous conceptualizations of risks throughout an organization, and ensuring that terms achieve both colloquial and scientifically precise standards.

M3-A.1 Goldstein BD; bdgold@pitt.edu

University of Pittsburgh Graduate School of Public Health

THE IMPORTANCE OF TAKING AIM: LESSONS FROM SETTING THE BENZENE WORKPLACE STANDARD

Setting targets is an important and often neglected part of protecting public health and the environment and one that is particularly pertinent to the current reinvigoration of OSHA. An example is OSHA's attempt to set a new workplace standard for benzene during the Carter administration which set off a fierce legal battle. In 1977 a markedly increased risk of acute myelogenous leukemia and other hematological cancers among pliofilm workers exposed to benzene was reported. As ostensibly exposure had been within the allowable workplace standard of 10 ppm TWA, the new head of OSHA, Dr Eula Bingham, promulgated an emergency temporary standard of 1 ppm TWA. The court sided with industry in overturning this new standard as there was no demonstration of an emergency as defined by the Oc-

cupational Safety and Health act, and there were revelations that workers had been exposed to benzene levels far in excess of the allowable 10 ppm standard. OSHA then went through a formal rulemaking process which led once more to instituting a 1ppm TWA standard. Again this was successfully fought by industry. The US Supreme Court decision in 1980 overturning OSHA's 1ppm standard in essence required OSHA to perform a risk assessment and was a landmark on the way to the NAS Red Book. But despite the failure of the Carter Administration to achieve a new benzene standard, the target that they set was eventually responsible for the 1 ppm benzene standard achieved by the pro-industry Reagan Administration in 1986. A major reason was that in 1977 the oil and chemical industries had not only directed their lawyers to fight the new standard, but they also directed their professional staff to find ways to meet this impending target. By the 1980s, industry found that it could meet the standard and turned to shaping the regulation rather than opposing the standard. To protect workers from risk OSHA needs to be willing to aggressively and proactively set and defend targets.

M4-B.4 Gormley AM, Rocks SA, Pollard SJT; a.gormley@cranfield.ac.uk

Cranfield University

MODERNISING THE UK GUIDELINES FOR ENVIRONMENTAL RISK ASSESSMENT AND MANAGEMENT: A CASE STUDY APPROACH

Risk analysts are increasingly challenged to supply the scientific rationale for decision making in a timely manner, sometimes with little data and mixed interpretations of the associated uncertainty. This research integrates advances in the field of risk analysis to revise the current UK Guidelines for Environmental Risk Assessment and Management (DETR/EA, 2000). The revision has focused on developments in scientific knowledge and information that supports risk assessment, and on improving the relevance of risk assessment through case studies that demonstrate the achievement of good practice. Preparation of the guidelines is part of a wider set of actions to build a network of risk practitioners and to encourage a more consistent (and good practice) approach to environmental risk assessment within the lead Government department. The new guidelines have been reviewed in draft form by persons chosen for their diverse expertise. Recommendations include: (1) pre-assessment deliberations that help formulate the risk management question, (2) a set of tools and techniques that deal with uncertainty, and (3) the identification of a broader range of options to manage the risk as a continuing process. These have been incorporated into a framework for risk assessment and management. The case studies that identify good practice within such a framework include: screening exposures during carcass disposal, assessing ecotoxicological risks for "down-the-drain" chemicals in surface waters, and qualitative evaluation of uncertainties in pesticide risks to birds. The revised Guidelines are expected to be used widely by environmental risk practitioners across the UK Government and its agencies, as well as consultancy firms providing risk assessment advice to Government.

M3-E.1 Greco SL, Belova A, Riederer AM, Corales M; sgreco@abtassoc.com
ABT Associates

SCREENING ANALYSIS OF NHANES BIOMARKER CONCENTRATIONS FOR EVIDENCE OF SOCIOECONOMIC DISPARITIES

Socioeconomic (SES) disparities in biomarkers of exposure have been examined for several individual chemicals, but to date a high-throughput, discovery-based analysis has not been available. We have screened a comprehensive set of biomarkers for potential SES disparity. The National Health and Nutrition Examination Survey (NHANES) publishes biomarker levels for approximately 6,000 U.S. persons, as well as demographic and other data. We evaluated 394 blood, serum, and urine biomarkers for evidence of SES disparity by income (Low/High Income) and race/ethnicity (Mexican American, Non-Hispanic Black, Non-Hispanic White) in the most recent 2-year NHANES cycle. We found non-overlapping confidence intervals (CI) of geometric mean (GM) concentrations for population sub-groups defined by income, race/ethnicity, or the combination for approximately 40% of the biomarkers in our analysis. This screening did not include control for multiple comparisons, so the large number of comparisons was expected to result in a substantial number of false positives (where non-overlapping GM CIs do not represent a true difference between populations). However, false positives are unlikely to explain the large number of apparent differences. This analysis identifies several chemicals that may merit further study (e.g., lead, furans, perchlorate, bisphenol A). It also raises questions about what metrics are most appropriate for identifying notable disparities, and demonstrates the strengths and limitations of discovery-based screening analysis of larger numbers of chemicals. Other differences across SES sub-groups such as age, sex, body mass index, or dietary patterns should be considered in interpreting the results.

T4-A.5 Greene CW, Shubat PJ, Ross M, Dady JM, Goeden HM, Moyer PF, Gust LD; christopher.greene@state.mn.us

Minnesota Department of Health

A PUBLIC HEALTH RESPONSE TO CONTAMINANTS OF EMERGING CONCERN

A constitutional amendment approved by voters in 2008 is funding a new effort by the Minnesota Department of Health (MDH) to expand its health risk assessment activities to include contaminants of emerging concern (CECs). The CEC program extends a preexisting guidance process for chemicals detected in groundwater to include potential drinking water contaminants. CEC program staff evaluate toxicity and exposure for pharmaceuticals, pesticides, personal care products, food additives, and other chemicals. In the first year of the program, staff have evaluated triclosan, 1,2,3-trichloropropane, and degradates of metribuzin, and have begun assessments for seven other chemicals. Staff have identified key stakeholders, who have communicated their expectations of the program and helped to establish screening criteria for chemical selection. Outcomes of the program have been influenced by the policy

framework in which the program was conceived. Selection and evaluation of CECs is based on their potential for exposure via drinking water; this has proven to be a constraint when evaluating chemicals that have significant exposure via other routes, including deliberate intake by the consumer. In developing guidance values for CECs, MDH used a preexisting methodology for groundwater contaminants; some CECs lack adequate toxicity data and cannot be evaluated under this scheme, but remain a concern because human exposure is known to occur. The focus on exposure via water ingestion may also obscure the greater issue of comparing risks to the known benefits of some CECs (such as pharmaceuticals). In addition, for many CECs a multimedia and/or multi-chemical approach is desired by stakeholders. To address these issues, MDH has explored the use of alternative methodologies, such as margin of exposure (MOE) and/or quantitative structure-activity relationship (QSAR). These methods may not allow an assessment of health risk, but may be informative for exposure management decisions.

M4-C.1 Gresh D, Deleris L, Evans D, Gasparini L, O'Reilly E, Spaccasassi C; gresh@us.ibm.com

IBM, University College Cork

WEB-ENABLED RISK COMMUNICATION

The communication of probabilistic information is a crucial, yet often understudied, aspect of risk management solutions. Risk models typically require careful elicitation of probabilistic input and a clear and unambiguous communication of the resulting risk estimation is necessary to give decision makers the support they need. In that context, we have begun several projects focused on a better understanding of risk communication, both in improving methods for eliciting probabilistic information and in visual aids for presenting such information. We investigate in particular web approaches. On the elicitation side, we have developed a web-based tool that facilitates the elicitation of the parameters of a Bayesian network in the context of having virtual/distributed teams. While there is a rich literature on elicitation, most approaches assume that the analyst and the experts will have the ability to meet face-to-face. If Bayesian networks are to be widely used in enterprise settings, it seems reasonable to challenge this assumption and explore the applicability of web-based approaches. On the visualization side, we are developing graphical presentation methods to allow the communication of information about risk in the context of a physician interacting with a patient over the topic of test results and their interpretation. We investigate the relative value in terms of patient understanding of several different presentation modes, all developed based on the large amount of research already done in the area of appropriate presentation of probabilistic data. In particular we explore the effect of interactivity and animation in the comprehension of the interaction of baseline condition frequency, false positive and false negative rates. We also address the relatively unexplored topic of uncertainty in the precise levels of the probability values.

M3-B.1 Grieger KD, Hansen SF, Linkov I, Baun A; kdg@env.dtu.dk
Technical University of Denmark, U.S. Army Corps of Engineers

A REVIEW OF FRAMEWORKS AND APPROACHES FOR ASSESSING ENVIRONMENTAL RISKS OF NANOMATERIALS

Assessing the environmental risks of engineered nanomaterials (NM) is currently an intensely contested subject among scientists, organizations, governments, and policy-makers. Due to the increasing number and diversity of NM in various applications, it is becoming clear that fulfilling quantitative risk assessment for NM is expected to be challenging, time-consuming, and costly. In this analysis, we evaluate and compare different environmental risk analysis frameworks and approaches that have been developed or proposed by large organizations or regulatory bodies specifically for NM. These frameworks are assessed according to a number of criteria which have been previously proposed as important parameters for successful risk assessment of NM including: flexible for a variety of NM, suitable for multiple decision contexts, incorporate uncertainty analysis, include life cycle perspectives, iterative or adaptive, enable more timely decision making, transparent, integrate various stakeholder perspectives, integrate precaution, and include qualitative or quantitative data. We find that most of the investigated frameworks and approaches are i) flexible for multiple NM and variations, ii) suitable for multiple decision contexts, iii) include life cycle perspectives, iv) transparent, and v) able to include qualitative and quantitative data. We also find that none of them addressed the challenge of timely decision needs, and only half incorporated some form of uncertainty analysis, mainly in simplistic identifications of ‘knowns’ and ‘unknowns.’ Furthermore most frameworks are mainly applicable to occupational settings with minor applications for the environment. We recommend the use of a multi-faceted approach to assessing the environmental risks of NM, in which different frameworks may be used and combined for the particular question considered. We also recommend further testing of these different frameworks and approaches on concrete real-world applications.

M2-G.6 Griffith WC, Krogstad FTO, Vigoren EM, Faustman EM; griffith@u.washington.edu

Institute for Risk Analysis and Risk Communication, University of Washington

LINKING OCEAN PROCESS TO HUMAN HEALTH RISKS FROM DOMOIC ACID IN SEAFOOD USING INTEGRATIVE BAYESIAN MODELS WITHIN A RISK BASED FRAMEWORK

We have used a risk based framework at the Pacific Northwest Center for Human Health and Ocean Studies to integrate mechanisms by which environmental conditions trigger blooms of harmful algae in our marine waters and with how these blooms impact public health and cause environmental disease. Domoic acid (DA) is produced by the diatom *Pseudo-nitzschia* (Pn). Consuming finfish or shellfish contaminated with DA can cause amnesic shellfish poisoning, including memory loss.

Populations potentially at risk are children & aging, high fish consumers (Tribes, subsistence fishers, Asian and Pacific Islanders), and those with underlying health conditions. Oceans and Human Health research is integrated through the “risk chain” connecting genetic and environmental factors with production of DA by diatoms as well as exposure and susceptibility factors which define human and ecological impacts of ingested contaminated bivalves. The risk chain allows us to move forward and backward to identify ocean and public health factors and policy needs. Two thematic questions guide the center : 1. how do environmental and genetic factors interactively affect Pn abundance, diversity and DA toxicity; 2. what geographic, physiological, temporal, and cultural/behavioral factors impact DA toxicity in humans and other organisms. We present two examples of how we use models to improve our understanding of the risk chain. Models of population dynamics of razor clams on the coast show that clams retain DA for much longer times than previously thought. Apparent decreases in DA in wild populations may be entirely explained by growth of the clams and mortality rates. Models of DA in blue muscles inside Puget Sound show that monitoring once every two weeks may lead to a high probability of missing blooms increasing the probability of public consumption of shellfish above the regulatory limits of DA. (This work was supported by NIH/NIEHS: P50 ES012762 and NSF: OCE-0434087 and OCE-0910624).

T3-A.1 Gruszczynski LA; lukasz.gruszczynski@eui.eu
Public University

SCIENTIFIC EXPERTISE AND ADJUDICATION IN THE WTO PRACTICE - MAPPING COMPLEX RELATIONSHIP

Contemporary legal systems are routinely faced with scientifically complex issues. One of the areas where this is particularly visible is environmental and health risk regulation. Here effective regulatory and adjudicatory decisions require recourse to highly specialized scientific knowledge. Scientists perform in this process a dual function: they identify and characterize risks, but they also validate possible solutions to control risks. A good example at the international level is the WTO Agreement on the Application of Sanitary and Phytosanitary Measures, which designates science as a benchmark for assessing legality of national health and environmental measures. Consequently, WTO adjudicators (panels) need to evaluate complex scientific data that are provided as a rationale for domestic regulations. My presentation is located in this context, as I intend to analyse interactions that take place between WTO panels and scientific experts providing assistance in settlement of such disputes. In particular, I concentrate on the process of information exchange between these actors. With respect to experts, I am interested in the following issues: how the legal logic, reflected in questions asked by the adjudicators, fit the scientific logic of experts; to what extent misunderstandings of legal concepts by experts have consequences for final legal decisions; how experts respond to trans-scientific questions. A parallel set

of questions will be asked with respect to adjudicators: how panellists understand answers of experts; how they resolve problems of contradicting opinions; how they establish minimal epistemic value of scientific evidence. My inquiry will be based on the analysis of the transcripts from the meetings with experts as well as factual determinations included in the final reports (e.g. EC - Biotech Products, Australia - Apples). This should allow me to identify both strengths and weaknesses of the current legal practice in the settlement of SPS disputes.

T3-A.4 Guidotti TL; tee.guidotti@gmail.com

National Medical Advisory Services

A PROPOSAL FOR THE REGULATION OF OCCUPATIONAL EXPOSURE TO NANOMATERIALS

There is a need for a consistent regulatory approach to nanomaterials. There are no clear studies to date that characterize the risks of nanomaterials under reasonable operating conditions; however the extrapolated risk of some resembles that of fine and ultrafine particulate air pollution, which could provide a “peg” by which to anchor a regulatory regime. The Canadian Council of Ministers of the Environment has adopted a Canada-wide standard (CWS) for PM_{2.5} (fine particulate matter at or below 2500 nm) of 30 mcg/m³ 24-h average, as the 98th percentile of the range permitted over any three year period, which took effect in 2010. This benchmark represents a convenient upper bound for an “almost” worst case scenario if applied to particulate nanomaterials. Being an environmental standard, the CWS seems appropriate for a hazard for which no threshold applies, that affects persons who are not susceptible, and no healthy worker effect is relevant. A benchmark occupational exposure level (not an occupational exposure limit, or OEL) of 30 mcg/m³ 8-h time-weighted average would be applied to nanoparticles that are believed to be relatively inert, at least until such time as their safety could be evaluated. Those with features likely to confer more biological activity (e.g. metal content, structural resemblance to a known hazard, and fibrous shape) would be subject to uncertainty or safety factors, possibly using the traditional factor of 0.1. The resulting modified exposure level would become the provisional standard for a specific product until sufficient data became available for a proper risk assessment. This low level of allowable exposure would undoubtedly drive control technology toward containment for many or most processes and in that sense is precautionary but would give the industry a firm basis for planning and a “level playing field”.

M2-H.2 Guimarães Pereira Â; angela.pereira@jrc.ec.europa.eu

European Commission - Joint research Centre

BEYOND NUMBERS: A HISTORICAL PERSPECTIVE ON PROBABILITY AND THE EMERGENCE OF PLAUSIBILITY

For a long time there have been signs that the way we utilise concepts like statistics and probability in order to make decisions and to motivate and justify policies,

is no longer practical. In this talk, we will explore, from a historical perspective, the emergence of the concept of plausibility, which we propose as a precursor of an inclusive, plural, and more genuine construct to appreciate situations where numbers are no more than a pale expression of people’s values, knowledge, anxieties, intuitions, and imaginations. The talk will briefly introduce epistemic, social and political developments in the past four centuries that lead to the rhetoric of numbers, identifying moments at which our usage of words, our colloquial language, was replaced by a constant invocation of numbers. Our historical account moves from the crisis of “exemplaria” to the emergence of statistics and probability and then to the rise of subjective probability. We assert that the use of subjective probability is a disservice to the analysis of many highly uncertain, complex situations, which leads to questionable proposals for action. We focus here on situations where we seek examples and models to follow, or to diagnose situations and deal with the unknown and uncertainty, or to make sense of the world and anticipate our future states. We encounter these in current environmental and societal contexts, technology development, and risk evaluation. For example, climate change, the financial markets’ collapse, and the recent BP oil spill in the Gulf of Mexico are the kinds of situations that need a different type of approach beyond risk and tiny (perhaps infinitesimal) probability estimates which fail to provide an adequate indication of potentially disastrous outcomes.

T3-E.1 Guo Z; zg9a@virginia.edu

The Center for Risk Management of Engineering Systems, University of Virginia

SPARSE DATA ANALYSIS USING HIERARCHICAL BAYESIAN MODELS WITH ASPECT-LEVEL CLUSTERING

In risk analysis of extreme events, such as the impacts from natural disasters or intentional attacks on the nation’s critical infrastructure systems, extra information is usually borrowed from other systems through Bayesian models due to the scarce historical data available to each individual system. Borrowing information from similar systems is more effective than borrowing from other unrelated systems. Cluster analysis is a widely used method of unsupervised learning, and a common technique to assign similar systems into groups. An important step in most clustering is to select a distance measure, which will determine how the similarity of two elements or systems is calculated. When systems have multiple aspects, each aspect is represented as one dimension in the distance measure space with different unit. However, in a high dimensional space, it is hard to assign and justify the weights for each system aspect for distance calculation, and the clustering results of similarity are difficult to interpret. The effectiveness of information borrowing is thus limited. The proposed methodology organizes these similar systems under a hierarchical structure and groups them at an aspect level instead of system level. That means an individual system doesn’t have to belong to only one cluster, instead, each aspect of the system can

belong to different aspect cluster resulting from one-dimensional clustering on that aspect. Based on this grouping structure, information borrowing is achieved through hierarchical Bayesian models defined at each aspect level. This approach provides a more intuitive way to model the relation between similar systems and outperforms system-based cluster analysis. It is especially useful in extreme event analysis where direct data is usually sparse. A numerical simulation of linear systems is used to show quantitatively the improvements on the accuracy and robustness on the estimations of system parameters.

P.94 Gutierrez VV; virna.gutierrez@udp.cl

Universidad Diego Portales and Pontificia Universidad Catolica de Chile

CLIMATE CHANGE: A RISK THAT CAN BE COMPENSATED TO BE ACCEPTABLE?

Chile has achieved significant economic progress in recent years, positioning itself as a country with one of the best prospects for development in the Latin American region. The internationalization of economies, increased technology transfer, and the division of production processes across borders has led the population's attitude towards risk change significantly. Moving from a more permissive society to a better informed one demands greater regulation, a better quality of life and, in general, lower public risk. In this study we describe how much trust people have in the authorities responsible for regulating Climate Change. We also described how the level of compensation (a new variable in the classic associationist model), people claim for the potential impacts of this hazard influence the relations between perceived risk, public acceptability and social trust. In 2008, 520 citizens of Santiago, Chile answered a survey. Data was analyzed using structural equation modeling procedures. The results show that trust in authorities and acceptability of Climate Change is low. In our model, the Acceptability of Climate Change is related to trust as well as the public's perception of risk and level of compensation. Implications for decision makers and public policies are discussed.

P.25 Haber LT, Prueitt RL, Goodman JE, Thakali S; haber@tera.org

TERA, Gradient

REPORT OF A WORKSHOP: AN EVALUATION OF HYPOTHESES FOR DETERMINING THE CARCINOGENIC POTENTIAL OF NICKEL-CONTAINING SUBSTANCES IN THE LUNG

The inhalation of nickel dust has been associated with an increased risk of respiratory cancer in workplaces that process and refine sulfidic nickel mattes, but the specific nickel compounds associated with risk have not been identified; a related issue is the nature of the carcinogenic agent. The nickel ion hypothesis proposes that the nickel ion is carcinogenic, and if it can be released from a nickel-containing substance, then that substance should be considered carcinogenic. Another hypothesis is that nickel ion bioavailability is critical. We (Gradient) conducted a novel weight-

of-evidence analysis of animal bioassays and mode-of-action studies to address this question. We found that relatively lower respiratory toxicity and clearance, higher intracellular uptake, lower extracellular dissolution, and higher intracellular dissolution-all factors associated with increased bioavailability of the nickel ion in the nucleus of lung epithelial cells-are associated with increased cancer risk. In contrast, the water solubility of the nickel substance is not correlated with cancer risk in these studies, suggesting that the presence of the nickel ion alone does not lead to an increased risk. The epidemiology data were also compared with the animal data (after adjusting to human equivalent exposures), but the epidemiology data are not sufficiently robust to determine which model is most appropriate. An expert panel workshop discussed this assessment, and reached unanimous agreement that the nickel ion bioavailability hypothesis is a refinement and enhancement of the nickel ion hypothesis. The panel agreed that nickel carcinogenesis is attributed to the nickel ion that is freely available at the target cellular sites, and that the ion's bioavailability at the nucleus is critical. While neither the mechanism nor MOA of nickel carcinogenesis is known, there was unanimous agreement by the panel that nickel does not act by direct DNA reactivity.

P.46 Hagan N, Robins N, Hsu-Kim H, Morris M, Woodall G, Halabi S, Bacon A, Richter D, Vandenberg J; Hagan.nicole@epa.gov

Oak Ridge Institute for Science and Education, North Carolina State University, Duke University, US Environmental Protection Agency, Office of Air Quality Planning and Standards, US Environmental Protection Agency, National Center for Environmental Assessment

LEGACIES OF MERCURY PRODUCTION AND USE IN THE ANDES: THE CASES OF HUANCVELICA AND POTOSÍ

Between 1564 and 1810, nearly 17,000 metric tons of mercury vapor were released into the atmosphere from cinnabar smelting operations in Huancavelica, Peru. In Potosí (present-day Bolivia) nearly 39,000 metric tons were released during amalgamation-based silver refining operations between 1574 and 1810. Mercury emissions from cinnabar refining and silver production were estimated from detailed Spanish records and maps from the colonial period. AERMOD was used to estimate historical ambient air concentrations of mercury in vapor phase from colonial mining operations during high, medium, and low production periods in Huancavelica and Potosí. Resulting 1-hr maximum and long-term concentrations were compared to present-day emergency response, occupational, and general public reference values to estimate potential historical risks from mercury vapor exposures. The AERMOD results were then used to select soil sampling sites along transects in Huancavelica and Potosí to assess present-day environmental concentrations of mercury from previous refining and smelting operations. The present-day soil concentrations of mercury follow the same gradient of ambient air concentrations predicted from historical emissions, with concentrations increasing substantially with proximity to historical sources. All soil samples contained mercury, with total concentrations

reaching 250 mg/kg in Potosí and 1,200 mg/kg in Huancavelica. Mercury concentrations in this soil collection ranged from 10 to 1,000 times greater than soils sampled from a non-mining town in Bolivia. These results indicate that the populations currently living in Huancavelica and Potosí may be exposed to high concentrations of mercury from historical contamination that may present significant health risks today. Disclaimer: This is an abstract of a proposed presentation and does not necessarily represent EPA policy.

W2-H.1 Hall IS; ian_s_hall@hotmail.com

Lloyds Banking Group

A CANADIAN, AN AMERICAN AND A BRIT WERE WALKING DOWN A STREET - USING MENTAL MODELS DERIVED FROM SCENARIO ANALYSIS WITH A GROUP OF EXPERTS TO CHANGE RISK TAKING BEHAVIOUR

This paper was written following the experience of the author and two colleagues who were involved in a real life risky situation whilst at the SRA conference in Baltimore in 2009. The research undertaken by the author set out to test a hypothesis that mental models derived from scenario analysis with a group of experts can be used to accurately identify the risks in a situation, and through examining framing effects of non-experts, behavior of actors when exposed to risk can be accurately identified and changed through risk education. The study found a number of common framing effects to be apparent within the mental models of the individuals studied, and the reasons for these were explored with this group. A series of risk education workshops were then undertaken, in an attempt to more closely align the mental models of individuals' with one created by a group of experts and reduce the framing effects. Following these workshops, a further study was undertaken to identify if risk taking behavior had changed, and if so, the reasons for this. The results of this are presented within this paper.

W3-B.1 Hallman WK, Cuite CL, Scheufele DA; hallman@aesop.rutgers.edu

Rutgers, The State University of New Jersey

PUBLIC PERCEPTIONS OF FOOD-BASED NANOTECHNOLOGY

Nanoscale materials have been used for decades and already appear in more than 1000 consumer products. Within the agriculture and food sectors, the adoption of nanoscale technologies is expected to have significant impacts on farmers and food. The current research was designed to examine the American public's perceptions of food-based nanotechnology, and to determine the parameters of public acceptance. Data were collected by an Internet survey research firm during the month of April, 2010. A nationally representative sample of 1210 American adults enrolled in the company's existing online panel responded to the 20-minute survey (66% completion rate). Initial levels of acceptance of nanotechnology were very low. For example, on an 11 point scale, where 0 represented "strongly disagree" and

10 was "strongly agree," the mean rating for "I would eat foods labeled as containing nanotechnology" was 2.5, and 74% of respondents gave the statement a rating of 4 or lower. However, the survey findings also indicate that a number of features of the product significantly affect Americans' expressed level of approval of nanotechnology in food products. These include: the specific product benefits (food safety and health benefits were the highest ranked), the congruence between product type and benefit type (health benefits were preferred in healthy foods rather than the same benefits in less healthy foods), the specific nanotech materials used (plant-based nanotechnology was preferred), and where the nanotech materials are located (nanotech packaging is preferred over having nanomaterials in the product or applied to the outside of the food). The findings indicate that while overall acceptance of nanotech foods may be low, certain applications of nanotechnology to food products are seen as more acceptable than others.

W2-I.2 Hamilton M, Lambert J, Ditmer R; mcg7w@virginia.edu

University of Virginia

STRUCTURING THE DESIGN SPACE FOR ENERGY SECURITY AT MILITARY INSTALLATIONS - GENERATING PORTFOLIO ALTERNATIVES FOR UNDERSTANDING THE RISK OF EMERGENT CONDITIONS

Securing energy for our military installations is an important part of protecting our national security and Homeland defense missions. There is general agreement that over reliance on publicly owned, aging grid infrastructure is a problem, and the military is looking into technologies that can help them to better assure that energy supply meets critical demand at all times. Furthermore, the military wants to lead the way for creating a sustainable and healthy environment through reducing consumption, increasing efficiency, and incorporating renewable and alternate technologies into installation infrastructure. With many technology alternatives and multiple objectives, the decision is further complicated by emergent conditions such political, regulatory, environmental, and technology changes. The goal of this study is to facilitate the risk analysis and strategic planning for the adoption of islanding energy technologies and policies on military installations. Each military installation has a unique design space. The technology performance, weather, building space, and operational missions vary from installation to installation, and their policymakers operate under different environmental, financial, and legislative constraints. This requires a systematic analysis of the design space, including energy consumption, generation, distribution, storage, and building criticality in order to elicit realistic energy alternatives. Such a systems-based approach allows stakeholders to formally track planning decisions so that the process can be repeated at different locations and time. Furthermore, structured and clearly articulated energy system alternatives will allow policymakers to use existing tools of multiple criteria decision analysis and emergent forced change

analysis to evaluate the performance and robustness of candidate alternatives. Thus, we develop a systems design model for eliciting alternative options using existing abstract systems engineering design methods and incorporate this approach with a multiple criteria decision and emergent conditions analysis.

W3-I.2 Han JW, Kim HK; hk646@cornell.edu

Cornell University

EXPLORING THE EFFECTS OF GOVERNMENT-PUBLIC RELATIONSHIP, ANGER AND COMMUNICATION BEHAVIORS ON PUBLIC ACTIVISM RELATED TO MAD COW DISEASE RISK

Due to the advancement of technology and the internet, activist groups have become more influential to policy change and governmental operations. In dealing with a public health issue that involves risks beyond general public's control (e.g., mad cow disease), favorable government-public relationship is important for minimizing confusions among the public. Guided by the Anger Activism Model (Turner, 2007) and Situational Theory of Publics (Grunig, 1997), this study explores factors that predict activism behaviors in the context of a mad cow disease risk issue in South Korea. Despite the reported cases of mad cow disease in the U.S., South Korean government decided to relax restrictions on imported U.S. beef, dramatically increasing public health concern about the safety of meat consumption. The government's decision was perceived as a failure to protect the country from mad cow disease resulting in a large scale antigovernment activism. The feeling of anger has been suggested to increase the likelihood of engaging in social activism and facilitate attitude and behavior change. Active communication behaviors (i.e., high problem recognition, high involvement and low constraint recognition) have also been used to categorize activist publics. To investigate the links between these factors, an online survey was administrated with 277 residents of Seoul, where the biggest rally occurred. This study reports four major findings: (1) intensity of anger is significantly related to activism behavior ($B = .61, p < .001$), (2) interaction between government-public relationship and anger negatively influences on activism behaviors ($B = -.21, p < .10$), and (3) publics with higher problem recognition ($B = .14, p < .05$) and lower constraint recognition ($B = -.16, p < .05$) are more likely to engage in public activism against government. This study provides a deeper understanding of profiling activist publics and their communicative behaviors related to a public health risk issue.

W3-A.3 Hanson RD; rhanson@gmu.edu

George Mason University

CATASTROPHIC RISK FORECASTS FROM REFUGE ENTRY FUTURES

Speculative markets have demonstrated powerful abilities to forecast future events, which has inspired a new field of prediction markets to explore such possibilities. Can such power be harnessed to forecast global catastrophic risk? One problem

is that such mechanisms offered weaker incentives to forecast distant future events, yet we want forecasts about distant future catastrophes. But this is a generic problem with all ways to forecast the distant future; it is not specific to this mechanism. Bets also have a problem forecasting the end of the world, as no one is left afterward to collect on bets. So to let speculators advise us about world's end, we might have them trade an asset available now that remains valuable as close as possible to an end. Imagine a refuge with a good chance of surviving a wide range of disasters. It might be hidden deep in a mine, stocked with years of food and power, and continuously populated with thirty experts and thirty amateurs. Locked down against pandemics, it is opened every month for supplies and new residents. A refuge ticket gives you the right to use an amateur refuge slot for a given time period. To exercise a ticket, you show up at its entrance at the assigned time. Refuge tickets could be auctioned years in advance, broken into conditional parts, and traded in subsidized markets. For example, one might buy a refuge ticket valid on a certain date only in the event that USA and Russia had just broken off diplomatic relations, or in the event a city somewhere is nuked. The price of such resort tickets would rise with the chance of such events. By trading such tickets conditional on a policy that might mitigate a crisis, such as a treaty, prices could reflect conditional chances of such events.

M4-C.4 Hart PS, Stedman R, McComas K; solhart@gmail.com

American University, Cornell University

AFFECT, PSYCHOLOGICAL DISTANCE, AND SUPPORT FOR CLIMATE CHANGE INITIATIVES

In response to climate change, universities are increasingly looking for opportunities to reduce their carbon footprint and use sustainable energy sources. This study investigates the predictors of local community support and opposition to elements of a climate action plan developed by a major New York university, which includes the development of windpower, forest carbon sequestration, enhanced geothermal systems, carbon offsets, bioenergy, and urban park and ride in the local community. Drawing from Construal Level Theory, which holds that individuals will have more abstract representations of objects that are psychologically distant and more concrete representations of objects that are psychologically close, this study examines how the role of affect in decision making may change depending on whether a proposed project is psychologically close or distant. The study was implemented by mailing a survey to 2,000 individuals who would be impacted by the proposed climate action plan, which resulted in 642 respondents. Respondents were given a brief description of the proposed projects, and then asked questions to assess their affective thoughts about the projects and their support for both near and distant project implementation. An OLS regression revealed that affective considerations had a significantly stronger relationship with policy support for near implementation than distant implementation. The results are discussed with respect to implications for risk communication and the role that affect and object representation may play in NIMBYism.

W4-B.5 Harthorn BH, Pidgeon N, Satterfield T; harthorn@cns.ucsb.edu
University of California at Santa Barbara, Cardiff University, University of British Columbia
WHAT'S NEW ABOUT NANO? NANO RISK PERCEPTION SPECIALIST MEETING JAN 2010

The Center for Nanotechnology in Society at University of California at Santa Barbara convened and hosted an interdisciplinary specialist meeting on Nanotechnology Risk Perception Jan 29-30, 2010. This presentation presents an overview of the meeting, the range of topics discussed, and its conclusions along with views about future research directions in the field. The group was convened by CNS-UCSB Director, Barbara Herr Harthorn, and her CNS collaborators, Nick Pidgeon (Cardiff U) and Terre Satterfield (Univ. of British Columbia) and included leading risk perception researchers (and SRA members) from the US, Canada, UK, Germany, Switzerland, and Portugal. Paul Slovic contributed a reflective overview at the conclusion on "The Problem of Early Stage Risk Perception." Participants contributed white papers on new work in progress, and the conference conveners are preparing a collection of papers for publication. More specific empirical and theoretical topics of interest to the conveners included: nanotechnologies as perturbing elements in conventional thought and practice about how scholars think about risk perception and governance; issues posed by emergent technologies for understanding amplification and attenuation of risk; cross-national differences in risk perception; application specificity of nanotech risk perceptions; novel methodological approaches to the study of emergent risk; "real risk" and perceived risk in the nanotech context; current views on if and how 'education' or deeper forms of deliberation shape risk perception; mental models and risk communication; politics of nanotech risk, risk perception, and regulation; constructed preference; gender, race and other social locations and differences as factors in risk perception; affect and risk perception; media and risk communication; and cultural values as drivers or shapers of perception.

M4-B.2 Hartley AJ, Foden W, Hemming D; andrew.hartley@metoffice.gov.uk
Met Office Hadley Centre

RISKS TO BIODIVERSITY FROM CLIMATE CHANGE: A TOP-DOWN APPROACH

We present a risk assessment approach to identify hotspots of extinction risk to biodiversity from climate change. The approach uses an ensemble of the most recent climate change projections, and elicits expert assessment of species' vulnerability to climate change. The magnitude of the change in climate and uncertainty in those estimates are assessed against the Holdridge Life Zone classification, which provides a biological context to climate information. Projected changes in climate are related to changes in life zones, which are then summarised by planning regions of relevance to a leading conservation NGO. The vulnerability of species due to traits susceptible to climate change has also been assessed against a range of criteria by biologists

whose expertise spans a broad range of taxonomic groups and geographic regions. Hotspots of risk are calculated using the exposure to life zone changes, measure of uncertainty in climate predictions, and the species vulnerability assessment. Results are then summarised to provide concise information for conservation planners.

W2-G.4 Hattis D, Lynch M; dhattis@aol.com
Clark University

UNCERTAINTY DISTRIBUTION FOR THE REGIONAL GAS DOSIMETRY RATIO (RGDR)—INTERSPECIES PROJECTION FOR WATER SOLUBLE/REACTIVE GASES

This work is part of ongoing efforts to develop a "Straw Man" system for probabilistic modeling of non-cancer risks-replacing existing single-point "uncertainty" and other adjustment factors with uncertainty distributions derived from empirical data. The RGDR is based on four component factors: total ventilation and upper respiratory tract surface areas for the test animal species and humans, respectively. For projections from rats, the RGDR is assigned a point-estimate value of 0.14 by EPA's IRIS-equivalent to a traditional uncertainty factor of 7.5. We develop component distributions for each of the four factors making up the RGDR, drawing on the most recent available information such as long term average ventilation rates for humans of different ages and measurements of human nasal surface areas from CT scans of children and adults. Monte Carlo simulations of the combined effect of uncertainties in the four RGDR component factors put the traditional 0.14 point estimate at about the 9.7th percentile of the combined uncertainty distribution-on the conservative side, as was probably intended. The presentation will cover the derivation of the component distributions and recipes for incorporating the combined uncertainty distribution into probabilistic risk assessments for category 1 gases such as acrolein and acetaldehyde.

W3-C.2 Haydarov R, Gordon JG; gordon@ksu.edu
Kansas State University

RESPONSES TO VACCINATION RECOMMENDATIONS IN AN EXPERIMENTAL FIELD STUDY BASED ON ATTRIBUTE AND GOAL FRAMING WITHIN MESSAGES

This experimental field study (N=476 adult females/average age 34 years) questioned how framing of risk and benefits of vaccinations attributes (likelihood of side effects) and how framing of the goal of vaccinations (likelihood of protection from disease) impacts responses to vaccination recommendations. Positive and negative goal framing, in combination with positive and negative attribute framing, were manipulated within messages making this the only study found to incorporate both attribute frames and goal frames in a unified advocacy context. Moreover, naturally occurring issue involvement was examined as a moderating factor exploring framing's relationship with information processing. The main effect is consistent with the

existing literature concerning typology of frames - the combination of the positive attribute and the negative goal frame was the only condition that was significantly more persuasive than the control condition. Moreover, results were analyzed in regards to participants' general pre-existing attitudes towards vaccines, perception of vaccine safety, perception of vaccine efficacy, vaccine dread, and vicarious experience with vaccine side effects. The online format of the study and the participant base of adult women not only replicates how many actually receive their health information but also allowed for a direct measure of information seeking behavior as an outcome adding to this study's ecological validity therefore contributing to the applicability of framing theory in preventive health message design.

W3-H.4 Hearl FJ, Pana-Cryan R; frank.hearl@cdc.hhs.gov

National Institute for Occupational Safety and Health

USING RISK ANALYSIS TO GUIDE CONTROL OF OCCUPATIONAL HEALTH HAZARDS

Occupational hygienists use risk assessment to identify, evaluate, and characterize workplace hazards. Once characterized, risk management and control strategies can be selected for remediation or amelioration of the occupational safety and health hazards. Risk analysis can often be used to control exposures using established occupational exposure limits (OELs). Unfortunately, there are only a limited subset of toxic substances which have OELs; approximately 800 chemicals have an established exposure limit. When an OEL exists, it gives context to the measured exposure concentration of a toxic substance, and provides a target for engineering control and guidance for the selection appropriate personal protective equipment (PPE), such as a respirator. Alternative methods for risk management are available when OELs are inadequate or non-existent. Methods available include applying expert opinion, hazard and control banding, and direct risk analysis. During the early phases of the 2009 novel H1N1 influenza outbreak, few data were available on the infectivity or virulence of the virus. There is no established OEL for a virus. The lack of data on the relative contributions of the various transmission routes lead to debate on the need for respirators against airborne transmission. Also, misunderstanding about the effectiveness of surgical masks and respirators as PPE combined with issues of supply and cost further complicated the situation. Disseminating clear and consistent recommendations for workers and the public from occupational health, public health, and infection control professionals was challenging. This paper describes processes needed to put risk analysis in action through the development of a recommended control strategy designed upon the principles of job hazard analysis and application of the hierarchy of controls for the prevention of exposure and reduction of risk for health care workers exposed to patients with influenza like illness.

M4-C.5 Hemming DL, Hartley A; debbie.hemming@metoffice.gov.uk

Met Office Hadley Centre

CLIMATE IMPACTS AND RISK ASSESSMENT FRAMEWORK (CIRF)

Risk analysis techniques are increasingly employed to assess and manage the impacts of current and future climate, and prioritise suitable adaptation options. This is now facilitated by the routine production of probabilistic climate change projections. To utilise these projections using appropriate risk analysis techniques we developed the Climate Impacts and Risk assessment Framework (CIRF). CIRF provides a generic and flexible process that is designed to guide consistent assessments of the risks of weather and climate impacts for a wide range of customers, sectors and locations. It has already been utilised to guide climate risk assessments for many projects. Here, we demonstrate the practical utility of CIRF through its application to a project to assess the current and future weather and climate risks to the West Midlands Fire Service (WMFS) in the UK. Pluvial flooding and vegetation fires were noted as the two main climate-related risks to the WMFS, based on the number of incidents that were logged for each of these during the period 1999-2009. For this historic period, the most frequent flooding events and most extreme number of vegetation fire events occur during the summer months (June-Aug). For flooding these are largely in association with high intensity precipitation incidents (>20mm/day), and for vegetation fires these are associated with duration and number of dry periods. By the 2050s, high intensity precipitation incidents are projected (assuming a high emissions scenario) to decrease during summer and increase in winter, and the number of long dry periods are projected to increase, particularly during summer and autumn. If we assume no change in vulnerability factors (which are significantly correlated with both flood and vegetation fire incident count), these projections would result in a decrease/increase in flood risk during summer/winter, with no change in the annual flood risk, and an increase in vegetation fire risk during summer and autumn.

T2-D.3 Hill AA, Swart A, Simons RRL, Kelly L, Hald T, Evers E, Snary EL; a.hill@vla.defra.gsi.gov.uk

Veterinary Laboratories Agency, National Institute for Public Health and the Environment (RIVM), National Food Institute, Technical University of Denmark

AN ANALYSIS OF POTENTIAL ON-FARM AND ABATTOIR INTERVENTIONS TO REDUCE HUMAN SALMONELLOSIS IN EU MEMBER STATES ATTRIBUTABLE TO PIG MEAT CONSUMPTION

Pigs are commonly infected with *Salmonella* spp. at the slaughterhouse, and the consumption of pig meat is hypothesised to be a significant contributor to human salmonellosis. The European Union (EU) will shortly set targets for the reduction of *Salmonella* in pigs at slaughter for each Member State (MS), and each MS is expected to put in place a National Control Plan (NCP) in order to achieve their targets. If MSs are to realise their targets then practical interventions that work consistently

must be identified. Pig production practices and national Salmonella prevalence will vary between EU MSs and therefore the effects of different interventions are also likely to vary. As part of the evidence base for the development of NCPs, a Quantitative Microbiological Risk Assessment (QMRA) was funded under an Article 36 grant to support the scientific opinion required by the EU from the European Food Safety. In this presentation we describe how the baseline model was modified to describe the effect of both on-farm and abattoir interventions, and the resultant reductions on the predicted number of human salmonella cases in an EU MS attributable to pig meat consumption. Here we present the results from two case study MSs with differing slaughter pig prevalence to exemplify the differences that interventions have between MSs. In the two MSs, both on-farm and abattoir interventions were predicted to be able to produce significant reduction in salmonellosis attributable to pig meat consumption, e.g. a 2 log reduction in carcass contamination through an abattoir intervention would reduce cases by around 50-70%. Combinations of interventions produced greater effects, but the relative increase in effectiveness depended on the specific type of interventions combined. Hence, MSs should carefully consider which interventions to implement in order to optimise the (cost)-effectiveness of their NCPs and wider control strategies.

W1-F.4 Hill AA, Simons RRL, Swart A, Kelly L, Hald T, Evers E, Snary EL; a.hill@vla.defra.gsi.gov.uk

Veterinary Laboratories Agency, National Institute for Public Health and the Environment (RIVM), National Food Institute, Technical University of Denmark

A FARM TRANSMISSION MODEL FOR SALMONELLA FOR INDIVIDUAL EU MEMBER STATES

The burden of salmonella entering pig slaughterhouses across the European Union (EU) is considered to be of public health significance. Therefore, targets will be set for each EU Member State (MS) to reduce the prevalence of salmonella infection in pigs at slaughter. In order to meet the set target, each MS will need to develop a National Control Plan (NCP). As part of the evidence base for these NCPs a Quantitative Microbiological Risk Assessment (QMRA) was developed (see accompanying Snary et al. abstract). In this poster we present the farm transmission model component of the QMRA, which was used to model the dynamic transmission of infection between pigs and investigate the effect of on-farm interventions in reducing human salmonellosis attributable to EU pig meat consumption. The farm model is a modified SIS model, which includes extensive modelling of individual pigs and the pig pen environment. The inclusion of the environment, and a novel dose-response model for salmonella in pigs, allowed the modelling of detailed interventions based on the cleanliness of the environment, and the susceptibility/immunity of the pig. Three potential sources of infection are considered: infected piglets, contaminated feed and environmental sources (e.g. rodents). The magnitude of shed-

ding by the sow was a good predictor of eventual batch prevalence in slaughter pigs, as the subsequently infected piglets became a large source of salmonella once mixed during weaning. As a direct result of this effect, it was concluded that MSs with high breeding herd prevalence (i.e. > 10-15% of breeding herds are positive) must tackle the breeding herd as part of any NCP in order to achieve a significant reduction in national slaughter pig prevalence. Conversely, it was predicted that MSs with a low breeding herd prevalence would benefit most from controls on feed contamination, as this becomes relatively more important when the sow is rarely a source of infection.

P.26 Ho WC, Lin MH, Pan SH, Lin YS, Chen PC; whocmu@gmail.com
China Medical University

GENDER EFFECTS MODIFY OZONE EXPOSURE RELATED TO CARDIOVASCULAR DISEASES MORTALITY

Air pollution related to cardiovascular disease mortality has been major concern in public health, furthermore being an in-volunteer risk. Ozone and PM2.5 could be important air pollutants related to the risk. Ozone related to cardiovascular diseases mortality was reported, daily cardiovascular diseases mortality in China and cardiopulmonary mortality in 96 USA metropolitan statistical areas. PM2.5 was related to increasing the risk of cardiovascular diseases mortality. Prevention of PM2.5 exposure could also be related to public health benefits. Multipollutant approach was assessed; PM2.5 could be used as a potential indicator pollutant. Furthermore, gender effects could be important in prevention/protection methodology and strategies. This study recorded daily mortality in relation to air pollution in Taiwan from 2006 through 2008. Sixty-four townships with air monitoring stations were analyzed. Mortality data were obtained from the Department of Health (DOH). Deaths due to cardiovascular diseases (ICD-9: 390-459) were analyzed in this study. The total number of death due to cardiovascular diseases (ICD-9: 390-459) was 30,084 during 2006-2008. Two major cardiovascular diseases mortality were cerebrovascular disease (ICD-9: 430-438, n=13,664) and ischemic heart disease (ICD-9: 410-414, n=6,995). Increased an interquartile ozone exposure could increase 5% of cerebrovascular diseases mortality and overall cardiovascular diseases mortality after controlling related risk factors including PM2.5, seasonal effects, temperature, relative humidity, fine particulate matters, age, gender, social economic status, and medical resources. Gender difference was observed in all ages, especially higher in younger age group.

M4-D.1 Hoffmann SA, Batz M, Morris JG; hoffmann@rff.org

Resources for the Future, University of Florida

ESTIMATING THE SOCIAL BURDEN OF FOODBORNE ILLNESS IN THE U.S.: COST-OF-ILLNESS AND QALY ESTIMATES BY PATHOGEN AND FOOD FOR ELEVEN LEADING PATHOGENS

Risk-based priority setting of food safety policy requires estimates of the distribution of foodborne hazards across the food supply. Policy makers also need to understand the severity of these outcomes in physical terms as well as in terms of the impact on the economy and human suffering. This study reports the results of an effort to model the impacts of foodborne illness in the U.S. for 11 leading foodborne pathogens. The study develops disease outcome trees for each of the pathogens based on scientific literature and primary data. On the basis of these disease outcome trees, it estimates the cost of foodborne illness and elicits QALY (EQ5D) scores for each pathogen. These multiple measures (cases, hospitalization, deaths, cost-of-illness, and QALY loss) are attributed to 10 broad food categories producing estimates of the social burden of foodborne illness by food for illnesses caused by these 11 pathogens.

P.47 Hollins DM, Galbraith DA, Finley BL, Sahmel J; dhollins@chemrisk.com

ChemRisk, Inc.

OCCUPATIONAL EXPOSURE TO DIACETYL AND POTENTIAL HEALTH EFFECTS: A WEIGHT OF EVIDENCE ANALYSIS

Since investigating potential health hazards of the Gilster-Mary Lee sentinel plant in 2000, the National Institute of Occupational Safety and Health (NIOSH) has conducted an additional 12 cross-sectional industrial hygiene and medical investigations in microwave popcorn, flavorings manufacturing, bakery, and commercial kitchen facilities. The conclusions offered in these NIOSH reports suggest that respiratory disorders are elevated in certain workers and that diacetyl appears to be a potential causative agent. We performed a weight of evidence analysis reviewing the existing animal toxicology and epidemiology studies for diacetyl and artificial butter flavoring substitutes, and completed a detailed analysis of the relevant NIOSH Health Hazard Evaluation (HHE) reports conducted to date. We conclude that there are still unresolved and significant gaps in the understanding of the health effects of diacetyl, and that as a result, definitive conclusions regarding its inhalational toxicity for occupationally-exposed workers are difficult to offer. Areas of future research that we feel would address these information gaps are discussed.

W1-E.1 Hong T, Gurian PL; th339@drexel.edu

Drexel University

A BAYESIAN MONTE CARLO APPROACH TO MODEL CALIBRATION FOR WEAPONIZED B. ANTHRACIS FATE AND TRANSPORT

The 2001 anthrax attacks not only caused the deaths of 5 people and hundreds of millions of dollars to clean the contaminated buildings, but also identified several critical knowledge gaps. Further understanding of the fate and transport for released pathogens will contribute fruitful information to risk characterization. The Bayesian Monte Carlo (BMC) method, is a robust tool for model calibration. BMC calibrates multiple model inputs by comparing model predictions with measurements. In this study, a published fate and transport model (Hong et. al., 2010) of pathogens' indoor air movement was selected. Uncertainty distributions for parameter from the selected model (eg., turbulence intensity, particle density, settling velocity, resuspension rate, distribution of particle size, etc.) were updated using the BMC method by comparing model predictions with measurements from a study focus on the secondary aerosolization of variable B. anthracis spores from one of the 2001 anthrax letter attacks (Weis et al., 2002). The results indicate that Hong's model overestimates released spores' settling velocity, while the resuspension process for the released spores has been underestimated. Also, the size distributions of released pathogens are estimated based on information acquired from surface measurements. This BMC application updated the parameter ranges in a complex indoor air fate and transport model and provided new insights on parameters' inputs and outputs.

P.81 Howe PD; peter.d.howe@gmail.com

Pennsylvania State University

THE CLIMATE PERCEPTION PROJECT: TESTING THE EFFECT OF LOCAL CLIMATE ON GLOBAL WARMING RISK PERCEPTIONS

This poster introduces the methodology and preliminary results of the Climate Perception project, which seeks to measure the effect of individual experiences of local climate on perceptions of global warming risk. Previous research suggests that the ways in which people experience environmental phenomena play a substantial role in attitude formation and behavioral response. The role of experience is, however, uncertain for chronic environmental hazards such as climate change or drought. For these slow-developing hazards, it is unclear both how people perceive the experience of such hazards at short time scales and to what extent these experiences shape risk perceptions and behaviors. Employing a multi-country dataset of micro-data from public opinion polls and historical climate indicators, the project features a novel methodology that uses multilevel modeling and spatial microsimulation to assess such a relationship between instrumentally observed climate indicators and public perception of global warming risk. Preliminary results suggest that local climate variability moderates the extent to which individuals weight short-term experience in their evaluations of long-term local climate changes.

P.74 Hsu X; johnxu0430@yahoo.com.cn
Risk Management of Willis Insurance broker in China

A REVIEW OF HEADWAY AND IMPACT OF RISK GUIDE AND CODE IN CHINA RECENTLY

Risk guide and code plays very important role in ERM and there was almost blank in this area in China before five year ago. In this paper, a review has been done to sum up headway and impact of risk guide and code of different industry, such as subway, high-speed rail, petrochemistry, waterpower in China recently. Finally, their impact and insufficiency has been discussed compared with some international standard.

T4-G.6 Huang CF; hchongfu@bnu.edu.cn
Beijing Normal University

SOME INITIAL THOUGHTS ON ESTABLISHING EXPERIMENTAL RISK LOGY

In a few dozens years, the subject of risk has become very popular and is much talked about at all levels of industry and government. Particularly, after the September 11 attacks, SARS outbreak in 2003, the Indian Ocean tsunami, and the bird flu virus, more and more people pay significant attention to risk issues. All of a sudden, it seems that everyone can do risk analysis, and whatever the model seems to could be called the risk model. What is even more ridiculous is that, in the National “flagship project” IRG (“Plan Integrated Risk Governance of China”), almost all of the project leaders haven’t any background in risk analysis. In my opinion, risk science is to discovery and study essential laws in risk phenomena, rather than coding something with so-called models. Perhaps, we can employ a probability model to measure uncertainty in a risk phenomenon. The probability distribution from the model might be nothing when nobody can prove that the hypothesis for the distribution is correct. To promote risk science becoming an independent science with its core, in this paper, we suggest to establishing a new discipline: Experimental Risk Science. Risk science is not a pure theory science, but an applied science. Of course, maturity is not only based on having been mathematically, but also on experimentally. Unfortunately, the current experiments on risk issues are the same as the experiments used in the fields related to the issues. For example, an environmental risk experiment is almost a chemical or a biological experiment. Referencing the inverted pendulum experiment in control theory and computer simulation experiment in management system based on their fundamental models, and regarding risk as a scene in the future associated with some adverse incident, we develop the Stone-Hook-Worker-Wind system into a Ball-Platform-Device-Power system, so that, we can model a simple pseudo risk, probability risk, fuzzy risk and uncertain risk.

T2-G.2 Huang Y, Haas CN; yh89@drexel.edu
Drexel University

MODELING THE INFECTIOUS EFFECT OF MULTIPLE DOSES OF SCRAPIE AGENT

Prions are self-replicating basic proteins of small molecular weight, which form new class of infectious agents responsible for a number of slow degenerative central nervous system diseases of humans and other animal species. To study the effect of multiple exposures to scrapie agent, a type of prions, we analyze the incubation period data from a prior work in which hamsters were inoculated orally with scrapie agent under three different dosing schedules. Animals in schedule 1 ingested the total dose in one challenge, while those in schedules 2 and 3 were each given the repeated challenges on ten occasions at the intervals of one and four days respectively. A class of time-dose-response models that incorporate the time distributions of in vivo pathogenic kinetics into classical dose-response models are expanded based on the independence hypothesis and fit to the incubation data. A model combining an exponential dose-response relationship and an inverse-Weibull function of time provides statistically acceptable fits to all schedules. Identical time parameter estimates in the inverse-Weibull function are observed across schedules while the dose parameter estimate for the exponential function decreases as the interval between successive challenges increases. The outcomes imply that, the doses may act synergistically when administered together and induce higher risk and/or the immune response triggered by prior challenge may reduce the probability of infection caused by following exposures, on the other hand, however, the distribution of pathogen kinetics appear unaffected. This study yields information on the mechanism by which the prion infection develops and potential strategies for controlling it.

M3-H.2 Huang I, Keisler J, Linkov I; ibhuang@mit.edu
Massachusetts Institute of Technology

MULTI-CRITERIA DECISION ANALYSIS IN ENVIRONMENTAL SCIENCES: TEN YEARS OF APPLICATIONS AND TRENDS

In recent decades, the application of multi-criteria decision analysis (MCDA) has expanded to a great number of fields. This presentation will review environmental applications of MCDA. Over 300 papers published between 2000 and 2009 were identified through a series of queries in the Web of Science database. These papers were reviewed in depth. The MCDA methods discussed in this review belong to several schools of thought (including analytic hierarchy process, multi-attribute utility theory, and outranking), and we present the results using a classification scheme that we developed. The articles were classified by their environmental problem, intervention type, or methodology depending on the emphasis of their application area. The results suggest that there is a significant growth in environmental applications of MCDA. Moreover, the annual growth of MCDA papers in the environmental field

was estimated to be 0.07%. Based on our investigations, we also identified trends and tools to aid future decision makers in their applications.

P106 Huang A-T, Nuckols J, Beane-Freeman L, Backer L, Blount B, Wilkes C, Branch R, Gordon S, Silva L, Cantor K; myumemail@yahoo.com
Occupational & Environmental Epidemiology Branch, Division of Cancer Epidemiology and Genetics, National Cancer Institute

INHALATION AND DERMAL EXPOSURE TO TRIHALOMETHANES DURING AND AFTER SHOWERING

Trihalomethanes (THMs), major disinfection byproducts resulting from water disinfection, have been associated with bladder cancer, other cancers, and adverse reproductive outcomes. One epidemiological study suggested an increased risk from THM exposure during showering and bathing but quantified internal exposure is lacking. The objective of this study was to estimate inhalation and dermal exposure to THMs during and after showering by utilizing monitored environmental and blood data and exposure models. Methods: We conducted an experimental controlled exposure study of 100 subjects who completed a questionnaire, took a 10-min shower in a shower stall, dressed in the bathroom for 5 min with shower off, and provided three blood samples for THM analysis: before showering; 10 min after showering; and 30 min after showering. The equilibrium concentration in the alveolar lung blood and absorbed THMs in stratum corneum were estimated by models using the monitored air and water samples before, during, and after showering; partition coefficients of THMs between the alveolar air and the alveolar blood; Fick's law with the non-steady-state differential mass balance; and blood samples before showering. Results: The median estimated inhalation intake of CHCl₃, a key THM, in the alveolar blood was 23 µg (interquartile range, abbreviated as IQR: 19.4-31) during showering for 10 min in the shower stall, and 3.4 µg (IQR: 2.8-4.3) during an additional 5 min in the bathroom without the shower on. The average inhalation exposure during the 5 minute period after showering was approximately 15% of the average during the actual shower. The median estimated dermal intake of CHCl₃ during showering was 34.6 µg (IQR: 28.8-39.2), which is higher than the total inhalation intake during the 15 minute exposure period. Conclusion: Remaining in a non-ventilated bathroom post-shower can increase total CHCl₃ exposure. During showering, dermal intake of CHCl₃ was higher than inhalation intake.

P17 Iverson S, Berglund J, Bastaki M; steffanapp@gmail.com
The Evergreen State College

AN ALTERNATE MECHANISM OF ACTION FOR ENDOCRINE DISRUPTION EFFECTS OF BISPHENOL A

Bisphenol A (BPA) is produced in high volume and products containing BPA are numerous and widespread. Public health concern rose from the fact that BPA leaches from plastics and lacquers into food and beverages at low concentrations, resulting

in widespread human exposure, and from laboratory evidence that it may cause endocrine disruption by binding to estrogen receptors. Research has mostly focused on the estrogen receptor (ERα) as the mechanism of action for which BPA shows very low binding affinity. Consequently, risk assessments of BPA tend to yield reference doses much higher than human environmental exposure and, along with its short half-life, imply low if any concern. However, recent studies revealed that BPA has a binding affinity for the estrogen-related receptor γ (ERR-γ) that is 105 times higher than its binding activity for ERγ, suggesting a much stronger potential for biological effects mediated through ERR-γ. ERR-γ is expressed in the placenta and the fetal brain, suggesting that this receptor may be a candidate target for developmental effects observed in vivo, specifically, that the size of the locus coeruleus (LC) (a small part of the brain stem) was reduced in male fetuses and increased in female fetuses exposed in utero to either 0.1 mg/L or 1 mg/L BPA in water. These studies suggest that BPA may have adverse effects at lower doses and encourages a new risk assessment. Using an RfD derived from this in vivo study, an average daily dose derived from recent publications of human exposure in the US (including preschoolers) through liquid and solid food, and air, and standard default exposure factors, we estimated a hazard quotient >1 and margins of exposure.

M4-C.2 Jardine CG, Driedger SM, Given LM; cindy.jardine@ualberta.ca
University of Alberta

COMMUNICATING ENVIRONMENTAL HEALTH RISK UNCERTAINTY - RESULTS OF A SYSTEMATIC REVIEW OF THE LITERATURE

Communicating the uncertainty associated with environmental health risks is a continuing challenge within risk communication theory and practice. A systematic review of the peer-reviewed literature in 38 databases representing various health-related and communication disciplines (including public health, psychology, sociology, education, business, agriculture, and environmental science) was conducted to consolidate and integrate the knowledge currently available on this area. Additional search strategies included a key journal search, key author search (109 noted risk communication authors), and a book (catalog) search. Articles were screened and evaluated based on established criteria for determining the quality of the both the study and information. A standard metasynthesis of the quantitative findings was conducted. Qualitative studies were synthesized using a combination of narrative (including traditional 'literature reviews' and more methodologically explicit approaches such as 'thematic analysis', 'narrative synthesis', 'realist synthesis' and 'meta-narrative mapping') and qualitative (which convert all available evidence into qualitative form using techniques such as 'meta-ethnography' and 'qualitative cross-case analysis') techniques. The research was guided by advice from a group of advisors representing regional, provincial and national health agencies to ensure that the information would be useful to practitioners. The results of this systematic review

produced evidence-based recommendations for communicating the uncertainty associated with environmental health risk. This included advice on the best methods, channels and timing for engaging the public in a dialogue about risks with associated uncertainty in exposure, effects and/or magnitude of health consequences. Data gaps were also identified. Finally, recommendations were developed for assessing qualitative evidence in systematic reviews based on this specific area.

T4-D.2 Jaykus LA, Anderson ME, Muth MK, Beaulieu SM, Mokhtari A, Bowles E, Newsome R, Paoli G, Dennis SB, Oryang D; steveb@rti.org
North Carolina State University, RTI International, Institute of Food Technologists, Risk Sciences International, FDA Cfsan

DEVELOPMENT OF INFORMATION TO SUPPORT RISK PRIORITIZATION USING THE IRISK MODEL

The Food and Drug Administration (FDA) is responsible for ensuring the safety and security of our nation's food supply. Because contamination of food commodities can occur at one or more points in the food supply system, FDA has been developing the tools and data needed to (1) characterize risks over a product's life cycle, and (2) prioritize hazard-commodity combinations based on potential risks to public health. FDA selected the iRisk model from among a wide range of risk prioritization modeling approaches to meet these needs; iRisk represents a significant step forward in risk prioritization, using a predictive, or bottom-up approach to produce a semi-quantitative characterization of the disease burden in the form of the pseudo Disability-Adjusted Life Years (pDALYs). Fully utilizing the capabilities of iRisk required an extensive data development effort to produce information on population groups, chemical and microbial hazards, dose-response relationships, health impacts, disease duration and severity scores, food commodities, and commodity process models. The body of information entered into iRisk was developed through an exhaustive review of the literature and publicly available databases, coupled with a formal expert elicitation designed to address particularly difficult issues such as cross-contamination. The data are specific to the hazard, food, or population, or they are specific to the hazard-commodity, commodity-population, or hazard-population combinations. Information currently available in iRisk includes eleven food commodities, detailed hazard profiles for 6 chemical hazards and 14 microbial pathogens, and comprehensive process flow diagrams for each food commodity. The development of supporting data for iRisk represents a critical step that will allow FDA to take advantage of the flexibility and features of this model to support a scientifically based approach to risk prioritization based on the pDALY as the comparative risk metric.

P.70 Jiang M, McGill WL; topjiang@gmail.com

The Pennsylvania State University

A SERIOUS GAME FOR ELICITING (AND POSSIBLY SHAPING) RISK PERCEPTIONS

The rapid development and proliferation of information technologies has changed the manner in which society searches for and receives information about current and emerging risks. Such technology, too, may also offer the benefit of capturing how society understands risk. One of the more appealing options for collecting data from human subjects is to do so in an entertaining manner. In recent years, the field of Games with a Purpose (GWAP) emerged and researchers have demonstrated that such games can be used to elicit user preferences. The present work proposes a serious casual browser game called "LinkIT". The scientific objective of the game is to collect data on how different individuals understand the causal (or any other) relationships between hazards in different situational contexts. The data collected during the course of this game will allow the game operators to construct subgroup mental models of risk expressed as influence diagrams. When sufficient data is available to construct high confidence influence diagrams at the subgroup level, the extent to which the understanding of risk is similar or dissimilar between subgroups can be measured (e.g., male versus female). Also, knowledge of how a subgroup's understanding of risk changes over time can be elicited and used to investigate the causes of such changes. Finally, through play against established influence diagrams, LinkIT can be used to possibly shape the players understanding of how factors are related to one another. This talk will describe and demonstrate the LinkIT game and discuss some of its strengths, limitations and challenges for implementation.

P.91 Jiménez R, Bronfman N; nbronfman@unab.cl

Andres Bello University

DEATH RISK ATTRIBUTABLE TO MOTORIZED VEHICLE TRAFFIC IN CHILE

Automotive road transport provides access to goods and services, and benefits for economic growth and social welfare. Nevertheless, the increasing reliance of development on this particular mode of transportation is resulting in adverse environmental and health effects. Chile's Metropolitan Region (MR) concentrates almost half of the nation's population and a similar proportion of the motorized vehicles registered in this country. This contributes significantly to the unusually high levels of atmospheric pollutants observed in this region. On the other hand, road traffic accidents in the MR are a major cause of external death and serious injuries. Until now, the health impacts of transportation have been dealt with separately and disregarding their cumulative effect. This study was conducted in order to develop indicators for Chile's MR that account for the negative impact that different types of motorized vehicles have on the environment and public health, bearing in mind the impact that

differences in technology and structure have on the health impact attributable to each category. The impact on health was measured as premature deaths caused by the exposure to traffic-related air pollution and road accidents per driven kilometre. The environmental levels of ozone and PM2.5 for each category were calculated to estimate the number of deaths attributed to exposure to these pollutants using epidemiology-based concentration-response functions. The number of road fatalities was obtained from historical data of traffic accidents. In accidents with two or more different types of vehicles involved, the responsibility of the resulting fatalities was attributed according to their participation in accidents and the magnitude of their consequences. The obtained results indicate that every year in the MR at least 3.319 premature deaths are expected to occur as a consequence of motorized transport, mostly due to exposure to air pollution attributable to this activity

M2-I.4 John R, Rosoff H; richardj@usc.edu

University of Southern California

MODELING THE DYNAMIC BIDIRECTIONAL INFLUENCE OF ATTACK THREAT AND COUNTERMEASURE DECISIONMAKING

Probabilistic risk analysis in the context of intelligent adaptive adversaries must incorporate the dynamic nature of terrorist beliefs, motivations, objectives, and preferences. Although both natural and industrial hazards may change over time, threats from these hazards are not contingent on mitigation measures taken. Threats from human adversaries, however, are likely to change in response to countermeasures taken to reduce the risk from the adversary. Unlike natural hazards or industrial hazards, threats from human adversaries can be expected to respond to countermeasures in an intelligent and adaptive manner. We present a generic system dynamics model capturing the interdependent dynamics of both attacker and defender actions. This model includes both physical assets, such as trained personnel, weapons, and defensive material, as well as psychological constructs, such as beliefs, motivations, and objectives. Time dependent levels of both physical and psychological variables are represented by stocks, and their instantaneous rate of change is represented by flow variables. The model further captures feedback loops that result in either escalation or control effects on the system. We explicitly account for uncertainty in the model, as well as important psychological components of decision making, such as risk attitude and trade-offs among conflicting objectives. Although adversary (attacker) strategies change, certain adversary parameters can be fixed to allow the defender to play-out alternative countermeasure policies and compare their outcomes. More detailed models for particular domains, such as biological, radiological, or chemical attacks, have the potential for aiding in development of specific countermeasure strategies.

W1-I.1 John R, Rosoff H; richardj@usc.edu

University of Southern California

DYNAMICS OF AFFECT, THREAT BELIEFS, PERCEIVED RISK AND INTENDED AVOIDANCE BEHAVIOR DURING A SCENARIO SIMULATION OF AN ESCALATING CATASTROPHIC BIOLOGICAL DISASTER

Risk perception research has focused on both cognitive and affective components of public reactions to both natural and manmade disasters. Psychologists have used a psychometric paradigm to explore various factors of risk perception. Sociologists have used a post disaster field research paradigm, conducting surveys and interviews with disaster survivors, to capture retrospective memories about their thoughts, emotions, and actions during the course of the disaster. Researchers using the psychometric paradigm typically rely on respondents' reactions and predictions related to hypothetical events in a cold, dispassionate context, and rarely ask respondents to react to an evolving disaster event. Researchers employing post-disaster field methods must rely on the (constructed) episodic memories of their respondents, who are also susceptible to social desirability biases. We present two studies, both utilizing a Scenario Simulation methodology, that uses a video simulation of a news report to immerse respondents in the grim details of the disaster. In one study we investigate public responses to a deadly flu virus, manipulating both the causal origin of the virus (terrorist attack, medical lab accident, unknown) and the proximity of respondents to the virus (local vs. opposite coast). Respondents total 600, half located near Washington, D.C., and half located near Los Angeles. Each respondent provides repeated reports of affect, threat beliefs, risk perceptions, and intended avoidance behaviors as the scenario escalates over time. In the second study we use the Scenario Simulation methodology to explore the reactions of local residents in the Seattle, Washington area to multiple terrorist attacks using weaponized anthrax. Our focus in this study is on structuring a decision model that incorporates perceived choices, uncertainties, and conflicting objectives for various stakeholder groups in the local Seattle area.

P.107 Coles JB, Zhuang J; jbcodes@buffalo.edu

University at Buffalo, The State University of New York

DECISIONS IN DISASTER RECOVERY OPERATIONS: A GAME THEORY PERSPECTIVE ON ACTOR COOPERATION, COMMUNICATION, AND RESOURCE UTILIZATION

The Indian Ocean tsunami which struck on December 26th, 2004, killed over 160,000 people and destroyed much of the infrastructure in the affected region. As a result, one of the largest international relief efforts in modern history was mounted to stabilize the devastated region, and save both life and property. Although sensitivity to cultural issues is challenging in the initial response phase, identifying and employing sustainable initiatives throughout the recovery phase is critical to the ac-

ceptance and long-term efficacy of aid provided to the region. With the recent disasters in Haiti and Chile in January and February 2010 respectively, the need for a more holistic approach to interagency cooperation has become increasingly clear in order to increase the efficacy of such partnerships. A lack of sensitivity to these critical issues could render the desired positive long-lasting changes or hamper the recovery of the region due to the failure to address economic and social issues in a culturally acceptable manner. Using perspectives from game theory, we discuss the potential for improvement in disaster management and cooperative strategies across the developing world by working on the problem of cooperative interaction between different agencies.

P27 Johns D, Luben T, Buckley B, Long T; johns.doug@epa.gov
US Environmental Protection Agency, National Center for Environmental Assessment

AN EVALUATION OF THE CONCENTRATION-RESPONSE RELATIONSHIP BETWEEN AMBIENT CARBON MONOXIDE AND CARDIOVASCULAR MORBIDITY: INTEGRATING EVIDENCE FROM ACROSS SCIENTIFIC DISCIPLINES

In the current review of the National Ambient Air Quality Standards (NAAQS) for carbon monoxide (CO), the U.S. EPA concluded that a causal relationship is likely to exist between environmentally-relevant short-term exposures to CO and cardiovascular morbidity. This determination was principally supported by results of controlled human exposure and epidemiologic studies, along with some animal toxicological evidence of cardiovascular effects following exposure to CO concentrations relevant to the NAAQS. Controlled exposure studies conducted among individuals with coronary artery disease have demonstrated a significant decrease in time to onset of exercise-induced myocardial ischemia following CO exposure resulting in carboxyhemoglobin (COHb) concentrations as low as 2.0%, with no evidence of a measurable threshold. Consistent with these effects, numerous recent epidemiologic investigations have observed positive associations between ambient CO concentrations and cardiovascular endpoints including hospitalizations and emergency department visits for ischemic heart disease. Despite these findings, there remains significant disagreement within the scientific community regarding potential cardiovascular effects of low-level CO exposure. An evaluation of uncertainties and complexities related to the interpretation of the observed associations between ambient CO concentration and cardiovascular morbidity is presented including: 1) biological plausibility of effects from low level exposures, 2) the relationship between community fixed site monitor CO concentrations and personal CO exposures, and 3) the possibility that CO concentration is serving as an indicator for another pollutant or mixture of pollutants. Disclaimer: The views expressed are those of the authors and do not necessarily reflect the views or policies of the U.S. EPA.

T4-F1 Johnson BB; branden.johnson@dep.state.nj.us
Rutgers University

GENDER NORM THREAT AND THE GENDER GAP IN RISK PERCEPTION

Researchers have been intrigued by an apparent difference by gender in risk magnitude ratings for decades, but have not explored quantitatively the degree to which this might be related to gender directly. Non-risk research has concluded that “manhood” is a highly vulnerable identity, and that threats to that identity can lead to physical aggression or expressions of homophobia in attempts to restore that identity. This is particularly true for men for whom manhood is central to their identity; women have not been found to be affected, nor “womanhood” to be a vulnerable identity. This conclusion led to the hypothesis that the request for risk magnitude ratings might be interpreted as threatening masculine norms if a man offered high ratings, and thus lower risk ratings among men might be an equivalent attempt to restore this identity. An online experiment manipulated whether men and women were told that their answers to various cultural questions were more similar to those of the other gender, to see if this would affect risk ratings for hazards found in earlier research to exhibit large gender gaps. Controls for gender identity centrality, and measures of anxiety and aggression, were included. Results will be discussed in the context of general explanations for the gender gap in risk perceptions.

W2-D.4 Jones DD, Subbiah J, Hanson BW; djones@unl.edu
University of Nebraska-Lincoln

A FRAMEWORK FOR FOOD BORNE ILLNESS RISK ANALYSIS OF FROZEN NOT-READY-TO-EAT MICROWAVABLE FOODS

In recent years, food borne illness and recalls of packaged frozen foods has created an increase in public concern over the safety of microwavable foods. Food borne illness has also led to multimillion dollar product recalls for manufacturers. Therefore, it is in the interest of both the consumer and the manufacturer that steps be taken to reduce the occurrence of food borne illness. In order to create a risk analysis of food borne illness, this paper describes a framework that will include the growth of bacteria during the life cycle of the food product. This life cycle includes the manufacture of the food product through consumption. The processes analyzed in the model will include raw ingredient production, manufacturing, transportation, and consumption. The probability of bacterial growth in each step will be determined using time and temperature histories that will inform bacterial growth models. The consumer section of the model will include newly developed microwave heat transfer models. Modeling the bacterial presence from raw ingredients to consumption will allow the model to produce a risk factor for food-borne illness during consumption. A holistic model will also allow sensitivity analysis to be performed to determine areas of high risk that could be targeted for risk reduction.

PRACTICAL ISSUES: PERSPECTIVES FROM A STATE REGULATOR

The assessment of the toxic potential of a chemical has great implications both in a regulatory context and in the public's perception of risk. Given their important role in the protection of public health, regulatory risk assessors have a duty to perform the most scientifically-defensible toxicity assessments consistent with their professional judgment and evaluation of available scientific literature, often preferring to err on the side of health-protectiveness when faced with unacceptable levels of uncertainty. This preference to err on the side of caution is reflected in historical and current risk assessment guidance and practice, which may result in a predispose reluctance to deviate from conservative defaults, even when supported by data. However, if erring on the side of conservatism significantly overestimates risk and is not sufficiently justified by the available scientific data, then harm to public health may result from diverting public, industry, and government attention and resources away from chemicals which may represent more of a public health risk at environmental levels. Specific examples of such chemical risk assessments, including formaldehyde, and the resultant regulatory challenges they create are presented.

W4-E.4 Julias C, Luke N; juliase@cdm.com

CDM

POTENTIAL RISKS OF POLYCHLORINATED BIPHENYLS IN HUMAN MILK TO INFANTS

Bioaccumulative chemicals, such as polychlorinated biphenyls (PCBs) have been known to accumulate in lipid tissue. For PCBs, exposure to the mother prior to breastfeeding is the most important exposure pathway since PCBs will accumulate in breast milk. Consequently, this pathway may pose a threat to breastfeeding infants. Therefore, human milk ingestion is a relevant pathway for sites contaminated with PCBs, and to include the breastfeeding exposure pathway in risk assessments is important to ensure that it is protective of infants. Evaluation of this pathway is included in the United States Environmental Protection Agency (EPA) Methodology for Assessing Health Risks Associated with Multiple Pathways of Exposure to Combustor Emissions. According to EPA guidance, an average daily dose to the mother is calculated based on the PCBs concentration, contact rate, exposure frequency, exposure duration, and body weight. The calculated average daily dose to the mother is used to obtain PCBs concentration in milkfat. The concentration in milkfat depends on half-life of PCBs, fraction of absorbed PCBs stored in fat, and a fraction of the mother's weight that is fat. The PCBs concentration in milkfat is then used to derive the average daily dose to the infant. Subsequently, carcinogenic risk and non-carcinogenic health hazard can be calculated for human milk ingestion. Calculated risks to infants support public health actions that encourage women to limit their exposure

to environmental contaminants, especially bioaccumulative chemicals, so that their infants can receive the optimal health benefits from breastfeeding. By minimizing exposures to pregnant females, it will ultimately lower PCB concentrations in the milk women produce for their infants. For PCBs contaminated sites, risk managers should be aware of and not overlook this important breastfeeding pathway.

P.15 Julias C, Marcum T, Luke N; juliase@cdm.com

CDM

RECENT UPDATES ON THE CARCINOGENICITY OF HEXAVALENT CHROMIUM

The carcinogenicity of hexavalent chromium (Cr VI) by the inhalation route of exposure has been recognized since the 1930's; however, only recently has evidence regarding carcinogenicity by the ingestion route of exposure been recognized. Results of the 2008 National Toxicology Program's (NTP's) chronic bioassay of rats and mice exposed to Cr VI in drinking water provided clear evidence of cancer development in animals by ingestion. As a result, the NTP chronic bioassay study concluded that Cr VI is likely to be carcinogenic in humans by ingestion. Furthermore, the New Jersey Department of Environmental Protection calculated a toxicity value for the human-equivalent cancer potency of 0.5 (milligram Cr VI per kilogram body weight per day)⁻¹ following the United States Environmental Protection Agency (EPA) guidance (EPA 2005) based on male mice. This oral cancer slope factor (S_{Fo}) permits quantitative evaluation of exposure to Cr VI and calculation of remediation goals based on the ingestion exposure pathway. As a result, the new S_{Fo} value for Cr VI is included in the 2010 EPA's Regional Screening Level Table. Additionally, EPA's Office of Pesticide Programs (OPP) concluded that the weight-of-evidence from the NTP study indicates that Cr VI may act through a mutagenic mode of action following administration via drinking water. Consequently, OPP has recommended that Age-Dependent Adjustment Factors (ADAFs) be applied when assessing cancer risks from early-life exposure (i.e., younger than 16 years of age). Using the new S_{Fo} and ADAFs in risk characterization will increase risk estimates associated with exposure to Cr VI. In addition, using the new S_{Fo} and ADAFs for the oral route of exposure as well as the inhalation criteria to develop remediation goals will result in a more stringent remediation criterion for Cr VI. Accordingly, for sites where exposure to Cr VI is a concern, remediation may be more costly due to more areas requiring cleanup.

P.2 Julias C, Marcum T, Luke N; luken@cdm.com

CDM

STATISTICAL APPROACH FOR BACKGROUND COMPARISON IN INORGANICS

Comparison to background is often used as a screening process in identifying a chemical of potential concern for further evaluation in risk assessments. For inorganics, statistical comparisons provide scientific basis to determine whether chemical

concentrations at a site are different or the same as background concentrations. Statistical comparisons are performed using hypothesis testing or by screening against a background threshold value (BTV). A hypothesis test compares mean concentrations of a site dataset to a background dataset. Depending on the data distribution, the hypothesis test can be performed using parametric methods, such as the student's t-test, or non-parametric methods, such as the Wilcoxon-Mann-Whitney test. Both parametric and non-parametric hypothesis tests may be performed using the United States Environmental Protection Agency's (EPA's) ProUCL Version 4.00.04 statistical software since this program includes the ability to deal with non-detect values. Results of the hypothesis test indicate whether site concentrations are greater than or equal to the background concentration. When a single site concentration, instead of a dataset, is compared to a background concentration, a BTV is often used as a screening value. The BTV is estimated by calculating a 95% upper prediction limit (UPL), an upper 95th percentile, or 95% upper tolerance limit (UTL) of background concentrations. The 95% UPL, the upper 95th percentile, and 95% UTL represent a single future observation; therefore, it can be used to screen an individual site concentration. For each inorganic, both hypothesis tests and comparison to BTVs are performed in a weight-of-evidence approach. Results from both statistical comparisons enable risk managers to make a more technically sound decision as to whether concentrations of an inorganic at a site are different from background and should be selected as a chemical of potential concern for further evaluation in the risk assessment.

T4-H.3 Kailiponi PK; kailipop@aston.ac.uk
Aston Business School

SPATIAL VULNERABILITY ASSESSMENT USING DASYMETRICS AND MULTI-ATTRIBUTE VALUE FUNCTIONS

Decision rules combined with geographic information systems (GIS) are commonly used to evaluate inter alia site suitability, hazardous material routing and social vulnerability. This combination of methods can be limited by arbitrary aggregation of units of analysis, assumptions concerning the distribution of data within spatial zones and creation of appropriate multi-attribute functions. A methodology to combine decision theory with spatial dis/re-aggregation (dasymetrics) will be discussed that allows for the comparison of attributes from dissimilar (non-commensurate) areas for multi-attribute decision problems. This combination of decision theory and spatial analysis can be significant for emergency managers as it: 1) allows for an analysis of non-commensurate spatial data, 2) limits the assumption of homogenous distribution of attributes within a GIS and 3) utilises multi-attribute value functions (MAVF) to allow for non-linear preferences for attributes and the inclusion of multiple attributes. The combination of decision theory and dasymetrics outlined in this paper will be illustrated in the creation of evacuation vulnerability mapping in the

United Kingdom. Spatial data of flood risk levels and vulnerable populations will be mapped using a multi-attribute value function (MAVF) to create an ordering of spatial areas that may require additional resources from emergency personnel given catastrophic disaster due to breaches to flood defences. Sensitivity analysis will be used to illustrate how non-linear preferences for factors and variation to attribute weights affect the ordering of flood-risk areas. The generalization of this combined methodology to other risk assessment scenarios utilizing spatial data will also be discussed.

P.99 Kaiser JP, Wesselkamper SC; Kaiser.Jonathan-Phillip@epamail.epa.gov
Oak Ridge Institute for Science and Education, US Environmental Protection Agency, ORD, NCEA

POTENTIAL MECHANISMS OF ENVIRONMENTAL CHEMICAL-INDUCED STEATOSIS

Non-alcoholic fatty liver disease (NAFLD) is the most common chronic liver disease in the U.S. occurring in nearly 30% of the population. NAFLD is characterized by several pathological changes with steatosis (fatty liver) representing the initial step in its pathogenesis. Steatosis is of critical importance because the prevention of fatty liver can obviate downstream pathologies of NAFLD (e.g., cirrhosis). Previous human and animal studies have shown a strong correlation between chemical exposures and fatty liver induction. The goal of our work was to identify chemicals that induce steatosis and investigate putative mechanism(s) by which these chemicals may contribute to this hepatic pathological condition. The U.S. EPA's Integrated Risk Information System (IRIS) is a human health assessment program that evaluates risk information on effects that may result from exposure to environmental contaminants. We mined the IRIS database for mammalian toxicity information on steatosis-inducing environmental contaminants. Interestingly, a majority of steatosis-causing chemicals were chlorinated compounds and we hypothesize that they may induce fatty liver by disrupting lipid metabolism via hepatic mitochondrial dysfunction. Furthermore, the most potent chemicals that induced dose-dependent fatty liver induction (e.g., mirex, chlordane, chlordecone) had the greatest degree of chlorination. Additionally, insulin resistance, impaired hepatic lipid secretion, and enhanced cytokine production were identified as other potential mechanisms by which chemicals could contribute to hepatic steatosis. Taken together, the work described here is significant because it identifies multiple pathways by which specific chemicals may cause fatty liver. This work also illustrates a link between dose-response and putative mechanisms for steatosis by showing that chemicals most effective in inducing fatty liver may do so by a common pathway: an enhanced ability to attenuate mitochondrial function.

P.8 Kajihara H, Inoue K, Ishikawa Y, Lin BL, Kishimoto A; kajihara.hedeo@aist.go.jp

National Institute of Advanced Industrial Science and Technology

RISK-RISK TRADE-OFF ANALYSIS ON THE SUBSTITUTION OF THE INDUSTRIAL CLEANER

Risk-risk trade-off refers to a situation in which one chemical substance for a certain purpose is substituted for another substance for reasons such as potential toxicity, but the initial risk is replaced by a new risk caused by newly used substance, might result in zero or minus net risk reduction. In this study, a risk-risk trade-off analysis was performed for the emission reduction measures applied to a chlorinated solvent used as an industrial cleaners. The analyzed scenarios are (1) baseline scenario in which a chlorinated solvent is used (2) cleaner substitution scenario in which the chlorinated solvent is replaced with a hydrocarbon-type cleaner or an aqueous cleaner, and (3) end-of-pipe measure scenario. The target chemical substances for risk assessment are trichloroethylene (TCE), dichloromethane (DCM) for a chlorinated solvent, n-decane for a hydrocarbon-type cleaner, alcohol ethoxylate (AE) which is a surfactant for aqueous cleaner and ozone which is produced by the photochemical reaction of volatile organic compounds in the tropospheric atmosphere. Both human health risk due to the inhalation exposure via the atmospheric environment and the ecological risk to the aquatic environment are evaluated. For the substitution scenario from DCM to n-decane, the human health risk due to exposure to n-decane is estimated to be smaller than that to DCM, however, the atmospheric concentration of ozone is estimated to increase by the substitution, because the ozone production potential of n-decane is larger than that of DCM. As a result, it is found that there is a possibility that a human health risk increases by the substance substitution in this scenario. For the substitution scenario from the chlorinated solvent to an aqueous cleaner, the increment in ecological risk is estimated to be very small as compared to the baseline risk. The cost per life year saved (CPLYs) estimated for each scenario is found to be very high, ranging from 500 million yen to 1,400 billion yen except for the increasing risk case.

W3-D.4 Kalinich J; kalinich@afri.usuhs.mil

AFRRI

CARCINOGENICITY OF EMBEDDED TUNGSTEN ALLOYS

A variety of unique metal mixtures have entered the military arsenals of many countries in recent years. These metal mixtures include the tungsten alloys, which have been proposed to replace depleted uranium in armor-penetrating munitions. As a result, opportunities for exposure to such metal mixtures as embedded fragments are increasingly likely. We recently showed that one of the tungsten alloys (tungsten/nickel/cobalt), when embedded as fragments, produced aggressive, metastatic rhabdomyosarcomas in rats. The need to confirm the carcinogenicity of these alloys

in another rodent species is an important second step required in biological as well as regulatory terms to better assess the cancer risk in humans. Using the B6C3F1 mouse, we have now shown that the tungsten alloy composed of tungsten/nickel/cobalt, but not the alloy composed of tungsten/nickel/iron, induces tumors at the site of pellet implantation. Results of this work will help in analyzing risk and formulating policies for surgeons who must treat personnel wounded by fragments of these alloys.

W2-I.1 Karvetski CW, Lambert JH, Ditmer RD, Keisler JM, Linkov I; cwk5b@virginia.edu

University of Virginia, STRATCON LLC, UMass Boston, USACE

EMERGENT CONDITIONS AND ENERGY ASSURANCE FOR MILITARY AND INDUSTRIAL INSTALLATIONS

"In an age of terrorism, combustible and explosive fuels and weapons-grade nuclear materials create security risks. World market forces and regional geopolitical instabilities broadly threaten energy supplies. Infrastructure vulnerabilities pose further risks of disruption to Army installations" [Army Energy and Water Campaign Plan for Installations 2007] Hundreds of military installations and industrial facilities need secure and reliable power generation to support critical and essential missions and operations. Grid outages relating to severe weather, intentional acts, and other events can result in cascading infrastructure failures as well as in security breaches and should be avoided. For example, a 2002 forest fire caused a Southwest Army Base to be down for sixteen hours, disabling mission capabilities and creating huge economic losses. Adding redundancy, increasing reliability, and reducing vulnerability can require additional environmental, financial, logistical, and other considerations and resources. Relying on backup diesel generators may not be the best practice and new technologies are better apt to supporting these critical and essential missions. However, these uncertain combinations of emergent conditions, including environmental, regulatory technology, and others, influence key decision parameters and the evaluation of tradeoffs among the alternatives. The integration of emergent conditions with multiple criteria decision analysis can address key uncertainties and vulnerabilities and aid in the selection of a robust investment strategy. Combinations emergent conditions can be filtered or grouped according to their relative influence within a decision context. We thus integrate the analysis of emergent conditions with multiple criteria decision analysis to identify combinations of emergent conditions that most influence the performance of energy security investments and demonstrate a preliminary benefits analysis of these investments for military installations and industrial facilities.

W4-D.2 Kause J; janell.kause@fsis.usda.gov

US Department of Agriculture

APPLICATION OF THE INTERAGENCY MRA GUIDELINE IN FOOD

The Food Safety and Inspection Service (FSIS) is the public health agency in the U.S. Department of Agriculture that ensures the nation's commercial supply of meat, poultry, and egg products is safe, wholesome, and correctly labeled. FSIS develops practical quantitative microbial risk assessments (QMRA) to inform various regulatory decisions, including recalls and tracebacks, risk-based inspection and monitoring systems, and, along with a cost-benefit analysis, to guide the establishment of economically significant regulations. These QMRAs are usually required by law and often require substantial data input and critical analysis. FSIS began developing these types of risk assessments in the mid-1990s. As the field of quantitative microbial risk assessment evolved, it became evident that there was a need for harmonization of microbial risk assessment techniques and approaches with other agencies. The Interagency Microbial Risk Assessment Guidelines developed in the U.S. provide the necessary framework to develop more standardized approaches for these types of risk assessments. Case studies will be presented on the use of these guidelines in developing quantitative microbial risk assessments for foodborne pathogens.

T3-I.3 Keeney RL, Levine ES, Bennett SP, Kolasky RP; keeneyr@aol.com

Duke University, Fuqua School of Business

COMPARING DIFFERENT TYPES OF HOMELAND SECURITY HAZARDS

The Department of Homeland Security (DHS) is responsible for homeland security hazards of many types, including nuclear bombs, induced pandemics, suicide bombers, imported crime, and illegal immigration. To make reasoned choices about the allocation of its resources to counter such threats requires the DHS have an understanding of the likelihoods of such events and of their relative significance. A procedural approach to use the knowledge of several individuals about various threats was developed and used to describe the range of concerns from such events. These were used as a basis to organize and structure a set of fundamental objectives appropriate for DHS to compare the significance of the different threats. The procedure, its use, and the results are discussed. The results are being used in the current homeland security national risk assessment.

W2-H.3 Keller C; ckeller@ethz.ch

ETH Zurich

THE INFLUENCE OF SPONTANEOUS ASSOCIATIONS EVOKED BY NUCLEAR POWER PLANTS ON THE ACCEPTANCE OF NUCLEAR POWER

Using a free association method, the relationship between the contents of the general public's spontaneous associations evoked by nuclear power plants and accep-

tance of nuclear power plants was examined in a quota sample (N = 1221) of age, gender and language region. In past research, the relationship between the affective ratings of the associations and acceptance has been analyzed, but the content of the associations has been ignored. Log-linear models revealed significant two-way interactions between association content and acceptance, association content and gender, and gender and acceptance. Correspondence analysis revealed that participants who were opposed to nuclear power plants, mainly associated with the risks, negative affect, accident, and radioactivity; whereas participants favoring nuclear power plants mainly associated with the energy, appearance descriptions of nuclear power plants, and necessity. Participants who were undecided often mentioned similar associations to those participants that were in favor. Males more often expressed associations with energy, positive consequences, waste disposal, and negative health effects. Females, on the other hand, more often made associations with severe accidents, negative affect, negative environmental effects, or appearance descriptions. The results of this analysis suggest that the content of the associations can be used to explain individual differences in the acceptance of new technology. Practical implications for risk communication are also discussed.

W1-H.3 Kellon DS, Arvai JL; kellonde@msu.edu

Michigan State University

SUPPORTING RISK MANAGEMENT IN DEVELOPING COUNTRIES: IMPROVING DECISIONS BY CONFRONTING DIFFICULT TRADEOFFS

For more than half a century, research and practice in international development has focused on improving the quality of life of people living in developing regions of the world. Recently, development agencies have recognized the need to include priorities associated with environmental sustainability as part of their mission. The presence of important-but often conflicting-social, economic, and environmental objectives in decision making for international development point to the inevitability of some difficult tradeoffs; the need to give up something valued in order to gain something else that is also valued but for different reasons. This presentation reports results from a study that compares two approaches for confronting environment-development tradeoffs in Costa Rica: (1) a stated choice (SC) approach that relies upon conjoint analysis and (2) a decision analytic method based on insights from multiattribute utility theory. Our research builds on a large set of previous experimental and case study initiatives, which show that rather than approaching decision problems with stable and thoughtful preferences that are merely revealed during decision making, people instead construct their preferences "on the fly" in response to cues that are available from past experiences or during the elicitation process itself. In this sense, deliberative processes and elicitation procedures have the de facto purpose of serving as architects of decision making as opposed to approaches that attempt

to reveal, as would an archaeologist, a decision maker's pre-existing preferences. This perspective of constructed preferences raises several challenges for SC approaches in particular. Chief among them is the problem of process validity; namely, the situation where objectives and associated attributes are presented in the SC survey but are not explicitly analyzed by respondents. This problem may bedevil even the most carefully designed SC surveys. Our results suggest that the use of a decision analytic approach can help respondents avoid this problem.

P.58 Kim HK, Bartolo D, Niederdeppe J; hk646@cornell.edu
Cornell University

EXPLORING ATTRIBUTIONS AND EMOTIONAL REACTIONS IN PROCESSING NARRATIVES ABOUT OBESITY

Increasing rates of obesity are a major public health concern in the U.S. Scholars have emphasized the need for addressing both personal factors (e.g., decisions to diet and exercise) and societal factors (e.g., neighborhood conditions and socioeconomic context) in designing messages to reduce health risks associated with obesity. Given their ability to influence model behavior and overcome reactance to persuasive advocacy, narrative messages have been proposed as effective strategies for delivering health and risk information. To provide a better understanding of how narratives about obesity are processed, this study focuses on elements of viewer's causal attributions (both societal and personal), blame towards a narrative character, and emotional responses (i.e., pity and anger), which are proposed as predictors of support for societal solutions to obesity. A between-subject experiment was conducted in which participants ($n=113$) were randomly assigned to one of three narratives with portrayed a main character who accepted varying levels of personal responsibility for weight control (i.e., high, medium, and low personal responsibility for diet, exercise, etc.). Guided by the Attribution-Emotion Model (Weiner, 1996), this study reports four major findings using correlation and regression analyses: (1) manipulated conditions induced different levels of personal responsibility while societal responsibility was kept consistent, (2) level of personal responsibility for weight control positively predicted viewer's blame toward narrative character ($B=.45$, $p=.01$), (3) blame was negatively associated with pity ($r=-.21$, $p<.05$) and positively with anger ($r=.24$, $p<.05$), and (4) blame was found to marginally mediate the relationship between personal cause and societal solution for obesity ($B=-.06$, $p=.03$). While narratives have been suggested to reduce resistance to persuasion, blame toward a character might increase the resistance to narrative health message.

T4-C.5 Kirby R, Turner MM; rowiekirby@yahoo.com
Center for Risk Communication Research, University of Maryland, College Park

ECOLOGICAL RISK PERCEPTIONS: A CARIBBEAN CONTEXT

A survey ($n = 159$), sponsored by the University of Maryland Center for Risk Communication Research, and based on the psychometric paradigm (Fischhoff,

1978; Slovic, 1987) was conducted in 2009 in the Caribbean country St. Vincent and the Grenadines, to determine the perceptions of risks associated with 20 ecological hazards, with a view to improving risk communication strategies. Surveys of this nature were not previously conducted in the Caribbean region, home to some of the most ecologically vulnerable islands in the world because of geographical and socio-economic factors. Hurricanes and volcanoes were given the highest ratings among most of the variables associated with the underlying factors that characterize ecological risk perceptions (Axelrod, McDaniels, & Slovic, 1999). Solid waste, which poses great local concern, was perceived as being among the most observable but most regulatable risks, and was associated with the highest level of anger and frustration. There were significant differences in means (with small to medium effect sizes) between perceived local threat and perceived threat to the Caribbean as a whole for 11 of the 20 risks (where local threat < regional threat). Significant differences in means (with small to large effect sizes) were also found between perceived local threat and perceived global threat for 17 of the 20 risks, including drought (Cohen's $d = 1.07$), deforestation (Cohen's $d = .71$), earthquake (Cohen's $d = .59$), habitat destruction (Cohen's $d = .71$), invasive species (Cohen's $d = .76$), global warming (Cohen's $d = .59$), and forest fires (Cohen's $d = .741$). Subjective judgments can be compared with objective probabilities to determine whether there is optimistic bias in comparative judgments of threat. Risk communication strategies should reflect the likelihood that people may be less inclined to take preventative measures in cases where optimistic bias is found.

P.84 Kizil GV, Bye A; g.kizil@mishc.uq.edu.au
The Minerals Industry Safety and Health Centre, SMI - The University of Queensland, Australia
RISK - COST - BENEFIT (RCB) SELECTION OF OPTIMUM EARLY WARNING TECHNOLOGIES

Potential solutions to both financial and personnel risk in the mining industry are often expensive, and both the risk improvement levels and financial benefit of potential solutions are poorly quantified. How then does a mining company make reliable decisions to implement these expensive technologies? A successful joint initiative, funded by the Australian Coal Association Research Program (ACARP), between MISHC and WH BRC has developed an innovative and unique 'Risk-Cost-Benefit (RCB) Decision Support Method', known as 'RCBgen' (Risk-Cost-Benefit Generator), to determine the complex risks, costs and benefits associated with safety interventions. The practical Method defines a methodology for identifying appropriate technologies/controls, assessing whether an appropriate technology/control reduces that risk, considering and determining an optimal group of technology/controls and calculating the net financial benefit associated with the appropriate technology/control. Technologies generally are developed for very specific risk situations. To evaluate effectiveness of controls the project has also developed another innovative and

unique new method, Risk-Control-Effectiveness Method, known as 'RCEmethod'. The RCEmethod investigates each technology/control including the reliability of the technology/control comprehensively by using semi-quantitative to quantitative data. The poster will introduce these two unique methods and outline RCBgen and RCEmethod application to the key mining related high risk areas: 1.Heavy Equipment Collisions 2.Highwall/Lowwall Slope Failure 3.Gas Outburst and 4.Surface Subsidence. A key message from the in-depth study is that the RCBgen has proven to be a valuable tool for selecting the optimum combination of appropriate technologies to reduce risk. The RCBgen can be adopted by other hazardous industries such as petroleum, oil, chemical and gas industries, and used as a 'pro-active scenario analysis tool' to address risks faced by these industries.

P.89 Klockow KE; kklockow@ou.edu
University of Oklahoma

SPATIAL RISK PERCEPTION IN DYNAMIC HAZARD EVENTS

When weather forecasters issue warnings, they consider a complex array of decision factors, including but not limited to forecast quality parameters such as POD (probability of detection) and FAR (false alarm rate), and lead-time goals geared toward providing as much value as possible to the end-user. Tradeoffs between these factors are unavoidable given constraints of technology and the present state of the science. To date, a good deal of research has explored the relationship between warning lead-time and behavioral responses, including both qualitative post-event case studies of vulnerability and aggregate statistical analyses of morbidity and mortality in an attempt to showcase the temporal dimension of forecast value for these particular hazardous events. While these studies are revealing, this dimension alone does not form a complete basis from which to consider problems such as repeated false alarm effects, to consider advancements in warning displays or even to have the assurance that those in the area of the warning understand their relationship to the hazard. Such issues implicitly involve deeper study of spatiality and spatial perception. This research aims to expand upon research focused on temporal dimensions of hazard response to include critical analysis of the spatial. Using theories of spatial cognition and risk decision theory, experiments and post-event analyses can be designed to reveal effects of positionality and risk perception on warning judgment. This presentation will explore the spatial-contextual issues surrounding warnings, highlighting theory, research design and research motivation, and preliminary results from an exploratory study may additionally be available.

W4-F.1 Kocian JL, Shirai JH, Kissel JC, Meschke JS; jkissel@u.washington.edu
University of Washington

ESTIMATED RISK OF MRSA COLONIZATION AMONG SWINE WORKERS

Background: The use of antibiotics in swine confined animal feeding operations (CAFOs) is believed to be contributing to an increasing prevalence of antibiotic resistant bacteria in the swine population, and in the facilities. Antibiotic resistant bacteria in these CAFOs may pose an occupational threat to human health. Among the resistant bacteria found when sampling swine CAFOs, methicillin-resistant *Staphylococcus aureus* (MRSA) is of highest concern. MRSA has been cultured from both swine and swine workers in Europe, Asia, Canada and the United States. MRSA has also been isolated from air and settled dust in CAFOs. Methods: In this study, we assessed the risks posed to worker health by MRSA in swine CAFOs using quantitative microbial risk assessment (QMRA) techniques. Probabilistic 2D modeling was used to characterize inhalation and surface routes of exposure to workers during a typical work-day. A Beta-Poisson model was used to predict the dose-response of MRSA colonization. The exposure model was populated with data from peer-reviewed literature on CAFO airborne MRSA concentrations, inhalation rates for laborers, fomite transfer rates, die-off of MRSA, etc. The dose-response model was parameterized based on data from *S. aureus* inoculation trials in humans. Results: The median dose for swine workers was predicted at 1.4×10^4 CFU over the course of the workday. The best fit parameters for the Beta-Poisson model were as follows: $a = 0.2879$, $b = 2261.3$, and $N_{50} = 2.3 \times 10^4$ CFU. The median predicted risk of colonization is 41%. QMRA was also effective in identifying data gaps in the current peer-reviewed literature. Conclusions: Swine workers are at high risk for colonization with MRSA and further attention is needed in evaluating possible interventions. Inevitable uncertainty present in this QMRA highlights the need to conduct further research to fill necessary data gaps

P.16 Kohrman-Vincent MJ, Maier A, Parker A, Haber LT; kohrman@tera.org
Toxicology Excellence for Risk Assessment (TERA)

EVALUATION OF CONCENTRATION-RESPONSE OPTIONS FOR DIACETYL IN SUPPORT OF OCCUPATIONAL RISK ASSESSMENT

The current emphasis on occupational exposures to diacetyl has led to new research on its effects. We evaluated whether the data are sufficient to develop a health-based occupational exposure limit (OEL) to support the transition from a hazard-based risk management approach to a quantitative occupational risk assessment approach. Inhalation health effects data were evaluated and issues and uncertainties related to occupational risk assessment needs were identified. A systematic hazard characterization, supported by both the toxicology and epidemiology literature, showed that the respiratory tract effects of diacetyl are the primary end points

of relevance for developing an OEL. A concentration-response assessment was completed using tracheobronchial (TB) effects in mice as the critical endpoint. The resulting benchmark concentration (lower bound estimate or BMCL) was adjusted to a human equivalent concentration of 1.8 ppm. A composite uncertainty factor of 10 was recommended to account for extrapolation from a BMCL in an animal study and for human variability in sensitivity. The resulting OEL recommendation of 0.2 ppm as a time weighted average was supported by the current occupational epidemiology literature. This evaluation showed that a health-based OEL value can be derived for diacetyl with moderate to high confidence.

P1 Kovacs D, Thorne S, Butte G, Chang F, Pakiam J, Hakkinen P; pertti.hakkinen@nih.gov

Decision Partners, LLC, US National Institutes of Health, National Library of Medicine

CRITICAL CRITERIA FOR DEVELOPMENT OF THE CHEMM ONLINE TOOL: EXPERT MODELS OF ITS ROLE IN EMERGENCY RESPONSE TO HAZARDOUS CHEMICALS

The National Library of Medicine (NLM) and its partners are developing the Chemical Hazards Emergency Medical Management (CHEMM) online tool, designed for first responders, first receivers and others. CHEMM will provide access to comprehensive sets of information needed in preparation for, and in response to possible exposures to hazardous chemicals. The goal of optimizing effective decision making in a chemical hazards emergency event is the basis of this effort to enhance the design and user interface of the CHEMM tool. NLM is using insight into how first responders, first receivers and other users think through and make decisions in a chemical exposure-related mass casualty event to design and validate the CHEMM tool using an expert model/mental models approach. As a first step, Decision Partners conducted a review of similar tools and other background materials and conducted interviews with a small number of experts to develop a simple expert model of Influence of the CHEMM Tool on Emergency Response to Mass Exposure of Hazardous Chemicals. This simple model was then used as the basis for a workshop with first responders, first receivers and other potential CHEMM Tool users, and has been supplemented by additional group discussions and interviews. The workshop and follow-up interactions identified critical criteria for CHEMM information content and quality for each likely user group. Also identified were CHEMM functionality and usability requirements for these user groups. The expert model is serving to guide the design and analysis of follow-up, in-depth mental models research with potential CHEMM users to further support the enhancement of the design and user interface.

W1-H.1 Krishen L; lkrishen@futron.com

Futron Corporation

FACILITATION OF AN ORGANIZATIONAL RISK EVALUATION PROCESS USING A NOVEL WEB-BASED RISK SCORECARD GENERATOR METHOD

Facilitating and capturing decision-critical risk information that is customized to the needs of several levels of decision-makers throughout and across multiple organizations is critical to a successful implementation of enterprise risk management (ERM) and risk-informed decision management (RIDM). Our approach focuses on implementation of a simple, worry generator-based approach that helps the risk assessor efficiently evaluate some top level risks, independent of their risk management experience or training. The utility of the process lies in its potential to capture and evaluate risk and decision information scenarios that are applicable to product, project, mission, corporate, or enterprise performance levels. We observed that categorizing potential risk assessors by their industry types and leadership roles helped define a logical approach with identification of critical risk factors. One of the challenging issues is defining global requirements that efficiently and easily communicate a structured approach to risk identification and information capture for users of all training levels—risk management (RM) novices to experts. To address this challenge, we developed and tested a web-based Risk Scorecard Generator tool that assists project managers, administrators, and technical staff in developing and evaluating risk profiles tailored to specific project and enterprise performance needs. From facilitated feedback, the application generates an online customized risk scorecard to rank and report those identified and selected risks. In addition to discussing the pros and cons of a risk factors-centric method in identifying and analyzing tailored risk and decision scenarios, we will examine the findings to date of the scorecard generator application. Overall, we found that the successful introduction to an ERM-compatible process centers on communicating the benefits of a risk-informed approach in making tough management and technical choices and decisions.

P.50 Krupka EA, Kirchner SF, Julias C; krupkaea@cdm.com

CDM, Edison, New Jersey

EVALUATION OF PCB ANALYTICAL METHODS TO SUPPORT RISK ASSESSMENT

Polychlorinated biphenyls (PCBs) are commercially-produced, complex mixtures of chlorinated hydrocarbons once used in a variety of industrial applications including transformer oils and hydraulic fluids. Due to their toxicity and persistence in the environment the presence of these compounds often drives risk decisions. The investigation of PCBs needs to be approached systematically to achieve data that is applicable to project objectives, while taking into account cost of analysis, as well as historical and future land use. The goal of this systematic approach for select-

ing a PCB analytical method is to provide risk assessors with sound, defensible data to evaluate current and future exposure pathways. There are three commonly used methods for PCB analysis for risk assessment that are addressed in this evaluation. EPA Method 8082 for aroclor analysis is useful as a relatively low-cost method for screening at most sites where release of a specific commercial Aroclor is suspected. However, it is not an effective method in cases where PCB mixtures have weathered, or for the analysis of biological samples where dioxin-like PCB congeners have bio-accumulated. It may also overestimate PCB concentrations at sites where more than one Aroclor is present. EPA Method 680 analyzes PCBs by homolog grouping and thus provides information regarding groups of PCBs present at the site, but does not provide information on specific PCB congeners. However, because each homolog group is directly identified, the chance of “double counting” PCB congeners is unlikely and thus this analysis may be used in quantifying Total PCBs. In contrast to the previous methods, EPA Method 1668 offers a higher cost analysis capable of detecting individual congeners. This method may be used in cases where PCB mixtures have significantly weathered and degraded over time, and where fish and other animal tissues will be analyzed for individual dioxin-like PCB congeners. To adequately assess risks due to exposure to PCBs, selection of an appropriate analytical method is critical.

P93 Kugihara N; kugihara@hus.osaka-u.ac.jp
Osaka University

EFFECTS OF AFFECTIVE VALENCE OF RARE EVENTS ON OVER-ESTIMATION OF FREQUENCY JUDGMENT

Three kinds of stimuli (photograph) were shown repeatedly to participants for twenty minutes: positive emotional valence (PO: e.g., scene of skydiving or sailing), neutral emotional valence (NU: e.g. spoon or tissue paper) and negative emotional valence (NG: e.g., blood-soaked body or badly-burned victim). These photographs were shown according to three type of schedule, HF (high frequency), MF (middle frequency) and LF (low frequency). As for HF, the presented frequency increased rapidly and reached the peak (60 times per minute) in two minutes, then decreased gradually. As for MF, it increased gradually and reached the peak (6 times per minute) in two minutes, then decreased. As for LF, it remained constant (0.6 times per minute) throughout the experiment. If a disaster occurs, mass media have a tendency to try to identify and pursue a target (e.g., a person, a group, organization, society, and culture) in charge of the tragic event. The frequency of the newspaper articles pursuing targets (scapegoats) varies and fluctuates through time. They, however, rarely aim their attack at their society or their culture. But some researches (e.g. Veltfort and Lee, 1943) indicate that transitions in scapegoats (targets) occur as time advances from persons or groups to society or to our culture. These transitions may be caused by our memory bias. That is, the rare targets picked up by articles overestimated and

also the degree of the overestimation increases as time advances. I thought we could regard a perception of number of articles and its fluctuation as estimation of varying frequencies of stimuli (photos). Results showed that perceived frequencies of NG-LF were overestimated, and the subjective peak of NG-LF appeared later than actual peak. On the other hand frequencies of NU-HF and PO-HF were underestimated, and estimation peak nearly corresponded to presentation peak. These results indicate the existences of biases of frequency and of its peak estimation.

T4-A.1 Kuzma J; kuzma007@umn.edu
University of Minnesota, Humphrey Institute of Public Affairs

DYNAMIC RISK GOVERNANCE FOR CONVERGING TECHNOLOGIES

Convergent technological products and applications at the nexus of emerging technologies like nanotechnology, biotechnology, and synthetic biology pose significant challenges for risk governance. These include a lack of risk-relevant data, a high degree of uncertainty about risks and benefits, rapid advances in applications over time, and important ethical issues associated with their use. In addition, regulatory authorities for converging technologies can be confusing, and redundancies and gaps in oversight may arise. These public administration issues are daunting and could take years to sort out. In the meantime, convergent products are entering multiple sectors like medicine, health care, environmental remediation, consumer products, agriculture, food systems, and manufacturing. Safety and public distrust are likely to become issues without upfront, proactive governance. The landscape of converging technologies is dynamic, yet current oversight approaches are largely static and difficult to adapt. This paper will first present a dynamic model of oversight that has resulted from a 4-year NSF-funded project on oversight of nanobiotechnology, which included expert and stakeholder elicitation, consensus approaches, and multi-criteria evaluation of historical oversight systems (Wolf, Kokkoli, Kuzma, Ramachandran, and Paradise, co-PIs). This model has three core elements which interact over time to adapt to technological advances and new information: a multi-stakeholder and expert coordinating advisory group, a process for public engagement, and a collaborative association of pertinent agencies. Next, case studies of specific convergent products will be used to illustrate the principles and operation of the model, as well as its approaches for gathering real-time, risk-relevant data for decision making and applying different oversight tools, as appropriate, over time. Finally, barriers to implementing a dynamic approach to oversight for converging technologies will be examined, and the feasibility of options for overcoming these barriers considered.

P104 Lamm SH, Robbins S, Chen RS, Lu J, Feinleib M; Steve@CEOH.com
Consultants in Epidemiology and Occupational Health, LLC, Georgetown University, Johns Hopkins University-Bloomberg School of Public Health, American University

THE EFFECTS OF DATA SELECTION ON ARSENIC CANCER SLOPE DIRECTION AND MAGNITUDE

Background: The U.S. EPA (2010) cancer risk assessment for inorganic arsenic ingestion, based on the Wu (1989) cancer data from the Blackfoot-disease endemic area of SW Taiwan, modeled the risk using the SW Taiwan reference population as a data point and the median village arsenic levels as the within-study exposure metric. Their sensitivity analysis demonstrated that both elements in the model were significant determinants of the risk estimate. **Method:** We have re-calculated the risk estimates by limiting the analysis to the study population and using the maximum village arsenic level as the exposure metric. Further, we have analyzed the data iteratively, removing the highest exposure villages sequentially in order to examine the risk behavior when limited to villages with low arsenic exposure levels (<200 ug/L). **Results:** Risk analysis using the data from the 42 study villages in the Wu (1989) study and their maximum village arsenic levels yielded a significant positive slope. The slope remained positive as long as the data set included villages with maximum levels of 256-1752 ug/L. The slope estimates lost statistical significance when the data set was limited to the 20) villages with maximum level < 400 ug/L. Finally, the slopes were negative when the data set was limited to the 15 villages with maximum levels < 200 ug/L. **Interpretation:** The cancer slope factor for arsenic is highly dependent on the choice of the data. Among villages with low arsenic levels (< 200 ug/L), the slope is negative. As data from higher exposure villages are included, the slope becomes positive and then significantly so. Further, when a large low exposure, low cancer rate reference population is added as a data point, the risk becomes markedly positive. The appropriate slope measure to use is dependent upon the question being asked.

W1-A.3 Lander DR; deborah.r.lander@usa.dupont.com
E. I. DuPont de Nemours and Company (DuPont)

EXPERIENCING REACH EXPOSURE ASSESSMENTS

A Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) regulation exposure assessment requires evaluation throughout the entire life-cycle of a substance to workers, to consumers, and to all spheres of the environment. Risk characterization is achieved by comparing the hazard benchmark to the estimated exposure for a particular use. If the exposure is below the hazard benchmark, the use is determined to be safe. DuPont has developed several quantitative exposure assessments for 2010 REACH registration. It is critical that experiences from REACH be used to inform TSCA modernization. One of the key issues in performing exposure assessment is that measured exposure data seldom exists. Therefore, validated models are often employed to simplify the evaluation. Without use of these

models, the necessary level of effort quickly escalates. These models, however, offer their own challenges because of the various inputs needed to perform the quantification. To simplify the evaluation and to ensure consistency, REACH created conservative exposure defaults as the quantification starting point. Using these defaults in the exposure models often results in overly conservative and unrealistic risk characterizations, necessitating extensive refinements. Industry Associations within the European Union (EU) were very active in refining exposure defaults. The one key area in which they focused was in estimating releases to the environment (air, water, and soil) for both industrial uses and consumer uses. A second key area was in developing consumer use scenarios. Industry-specific emission criteria were issued to be used in place of the REACH defaults. They have also made standard use scenarios available including realistic consumer use scenarios. These efforts have resulted in conservative but reasonable refined inputs for the REACH exposure models. Based on these experiences in estimating and refining human exposures, useful approaches for TSCA modernization will be discussed.

T4-E.5 Landis WG, Kolb Ayre K, Markiewicz AJ, Stinson JM; wayne.landis@wwu.edu

Western Washington University

A WATERSHED BASED REGIONAL RISK ASSESSMENT AND MANAGEMENT TOOL FOR THE SOUTH RIVER, VA USING BAYESIAN NETWORKS AS A COMPONENT

This regional scale risk assessment for the South River has two primary functions: 1) perform a multiple stressor ecological risk assessment for the area that Hg and other stressors within the watershed and 2) create a modeling framework to calculate the change in risk with different management scenarios to assist in the restoration of the watershed. The selection of endpoints has been completed and includes water quality, species specific to the region, recreational uses and park activities. Sources include Hg contaminated sites, stream modification, discharges, effluents, roads, natural resource activity and land uses such as agriculture and residential areas. Six risk regions have been identified from just upriver of Waynesboro to just past the confluence of the South River with the North River and Shenandoah. The structure of the risk assessment is similar to that of the relative risk model but with a Bayesian network being used to calculate risk and uncertainty. The Bayesian network reflects the causal pathways expressed in the conceptual model, can incorporate the broad array of data available for this site, and can use expert opinion when necessary. Uncertainty is explicit and sensitivity analysis is used to identify influential variables. Scenarios can also be easily explored using Bayesian networks as part of a process to examine the usefulness of proposed remediation plans. The presentation will report on the results of the risk calculations and the interaction with discussions regarding remediation options.

W2-E.4 LaRocca S, Guikema S; larocca@jhu.edu

Johns Hopkins University

NETWORK TOPOLOGY AND VULNERABILITY IN INFRASTRUCTURE SYSTEMS

Many critical infrastructure systems are comprised of complex physical, geographical, and logical networks. Such systems include electric power, drinking water, wastewater, cellular communication, internet, and transportation. Understanding the effect of a network's topological characteristics on system reliability is a key element in conducting risk analyses for such systems. In this paper, we use various topology generation algorithms, including both power-law and exponential algorithms, to generate a large set of random networks encompassing a wide range of sizes and topological characteristics. We then evaluate the reliability of each network under both targeted and random element failures. These scenarios represent both natural (random) and man-made (targeted) hazards to infrastructure systems. This paper provides an understanding of the effect of network characteristics on systems reliability.

M4-I.4 Lathrop JF, Ross RG; lathrop3@llnl.gov

Innovative Decisions, Inc.

BEYOND PROBABILITIES TIMES CONSEQUENCES: A STRATEGIC APPROACH TO TERRORISM RISK MANAGEMENT

Terrorism risk management is a challenge where probabilistic risk assessment (PRA) simply does not provide adequate support for risk management. Six problems: 1.) Adaptive Adversaries: can shift targets and tactics in response to countermeasures; 2.) They can deliberately pick scenarios "not on our list"; 3.) Game-Changing Risk Events: e.g. a country deciding to aid a terrorist organization, can dramatically change key probabilities and capabilities literally overnight, leaving us with key challenges in nonstationarity and non-robust probabilities; 4.) "Time's Arrow:" as time goes on, terrorists will encounter other terrorists, experts, access, knowledge and capabilities, all with the effect of upward step functions in terrorist capabilities; 5.) Mismatched Time Constants: Each of the four previous challenges leads to changes in the threat spectrum that are much more rapid than the US process to decide on, R&D and deploy countermeasures; 6.) Leverage: The US is a target-rich environment, and that combined with other factors provides terrorists with leverages against the US. But more broadly, PRA approaches characterize the problem at a defensive-tactical level, where what is called for is a strategic level of risk management in this Game Against Multiple Adversaries. This paper will lay out a terrorism strategic risk management approach that addresses the six challenges listed. Two key features of the approach: 1.) "Dueling Portfolios," the Blue portfolio of countermeasures against the Red portfolio of attacks; 2.) Quality of Position metrics capturing resilience, robustness, preparedness for scenarios not on the list, and disincentivization. Key concept: When you find yourself in an unfavorable game (such as defensive-tactical deploying countermeasures one target/scenario at a time), change the game.

Also: When you find yourself pursuing an analysis that cannot capture the risk generating process (such as PRA in this context), change the analysis.

W2-F.4 LaVail KH, Allen-Catellier J; khlavail@buffalo.edu

University at Buffalo

ILLNESS OR CRIME: FRAMING PRESCRIPTION AND ILLICIT DRUG USE IN ONLINE TABLOIDS

The abuse of illicit and prescription drugs by college students has remained a concern to health professionals (Volkow, 2009; Willoughby, & Carroll, 2009). One venue college students are getting informal drug information is from online gossip websites that frequently feature stories about the habits of influential and/or notable celebrities' drug use (Jo rnebring & Johnsson. 2004). This article sought to compare the frames used in coverage of illicit and prescription drug use in the three most popular celebrity gossip websites, TMZ.com, OMG!, and Pop Eater. Frame analysis was used to identify the dominant frames in the coverage and then determine how each frame was shaped by the frequency of meta-frames (Goffman, 1974). Three dominant frames, legal, social, and health, emerged from a review of the literature. The articles (N= 149) were selected using general and specific search terms in the online archives of the tabloids. The results were analyzed using chi-square goodness of fit tests. The findings indicate that prescription drug abuse is still regarded as primarily a medical problem, while illicit drug abuse is portrayed as a legal problem. The disparities in frames between the two drug families project an image of prescription drug abuse as a medical issue, free from consequences associated with illicit drugs. Illicit drugs abuse is portrayed as criminal, with little consideration of the health consequences and concerns associated with any drug use. This would indicate that current online tabloid coverage of illicit and prescription drug use under-emphasizes the dangers associated with their abuse. This could signal readers that prescription drug use may bear less legal threat, while illicit drug use poses less associated health risks.

P.7 Lavelle KS, Schnatter AR, Travis KZ, Swain GM, Pallapies D, Money C, Vrijhof H, Priem P, Onyen L; karlene.s.lavelle@exxonmobil.com

ExxonMobil Biomedical Sciences, Inc., Syngenta, The Dow Chemical Company, Institute for Prevention and Occupational Medicine of the German Social, Exxon Mobil

FRAMEWORK FOR INTEGRATING HUMAN AND ANIMAL DATA IN CHEMICAL RISK ASSESSMENT

Although risk assessment results are likely most valid when all relevant lines of available data (epidemiologic, toxicologic, in vitro) are considered, efforts to do so have been constrained by the lack of clear, objective guidelines for how and when to incorporate different types and qualities of data into the process. Consequently, a risk assessment may lack the systematic methodology and scientific rigor necessary to produce valid and reproducible results. In this poster, we describe a methodological framework for evaluating, classifying and integrating human and animal data into

the risk assessment process and demonstrate through case study examples how this framework can be implemented. We address the methodological gaps of existing proposals by incorporating several key features that include (1) a balanced appraisal of both human and animal data, (2) relevance to different stages of the risk assessment process, and (3) accommodation for different data quality requirements based on the nature of the endpoints under consideration (e.g. acute v. chronic effects) and specificity of the health effect (i.e. whether the chemical of interest is correlated with a specific health endpoint). Application of the proposed framework to a wide variety of chemicals will improve transparency of the process and validity of risk assessment results, while informing continuous improvements to this evolving methodology.

M3-C.3 Le MH, Paustenbach DJ; mle@chemrisk.com
ChemRisk, LLC

THE IMPACT OF THE GLOBALLY HARMONIZED SYSTEM OF CLASSIFICATION AND LABELING OF CHEMICALS (GHS) ON THE CHANGING REGULATORY LANDSCAPE OF HAZARD COMMUNICATION

The regulatory landscape concerning hazard communication started to transform with the implementation of the United Nations' Globally Harmonized System of Classification and Labeling of Chemicals (GHS) in 2003 and OSHA's 2009 notice of proposed rulemaking to align its current Hazard Communication Standard (HCS) with the provisions of the GHS. The GHS is based on the principle that existing systems around the world should be harmonized in order to develop a single, global system to address chemical, label, and safety data sheet (SDS) classification; including standardized criteria for health, physical, and environmental hazard classification and labeling. While OSHA's proposal to adopt the GHS will not change the scope of the current HCS, the focus of some provisions within the standard will shift from a performance-oriented design to requiring explicit requirements for how components of hazard classification, labels, and material safety data sheets (MSDSs) should be prepared and implemented. This presentation will describe the affected components of the HCS and provide an analysis of the benefits and challenges that will face organizations in conforming to the proposed amendment. Major changes to the labeling component of the HCS will include standardization of labels, symbols, signal words, and hazard statements assigned to each of the three GHS hazard categories (health, physical, and environmental). Changes to MSDS requirements will include a specified order of presentation for a 16-section data sheet covering health, physical and environmental hazard criteria for substances and mixtures. While affected organizations are expected incur costs related to the reclassification of chemicals, revision of labels and MSDSs, and additional training of employees on the new label elements and MSDS format, the amendment is expected to create a dramatic reduction in safety and health risk while increasing productivity in comparison to the current provisions of the HCS.

T4-H.1 Lee RC, Forman S, Culpepper J, Richards M; rlee@neptuneinc.org
Neptune and Company, Inc., University of New Mexico

RISK ATTITUDES AND PERSONALITY CHARACTERISTICS OF EMERGENCY PHYSICIANS

Emergency physicians work within a high-risk, high-stress environment and are required to make difficult and often life-and-death decisions, typically under a great deal of uncertainty. Additionally, many emergency physicians voluntarily engage in 'risky' pursuits such as rock climbing, mountain biking, etc. outside of the working environment. Risk attitudes may determine in part how physicians select their specialty and how they practice medicine, and physicians in general are an under-studied group in terms of risk attitudes. In the interest of improving safety in the emergency department environment and informing appropriate resource allocation and recruitment, a study was designed to elicit risk attitudes and personality factors of emergency physicians in a large public teaching hospital (the University of New Mexico in Albuquerque, NM, USA). A web-based survey was designed that incorporates the Domain Specific Risk Taking (DOSPERT) scale of Weber et al. and a standardized "Big Five" personality inventory to capture risk attitudes and personality characteristics, respectively, across multiple domains. The reliability of both surveys has been extensively evaluated in a variety of contexts. Additionally, demographic information (gender, age, years in practice, etc.) was collected. Invitations to take the self-administered survey were sent to 96 physicians, including both attending (faculty) and resident (in-training) physicians in emergency medicine. All surveys were confidential with the investigators blinded to the identity of the respondents. Approximately 63% of physicians have responded to date. The results of this study will be presented, along with statistical analyses of the associations between risk attitudes, personality factors and demographic characteristics. A follow-up study is being designed in which performance of physicians in a simulated environment will be compared with their risk attitude/personality profiles.

P.59 Lee LK; lewis_k_lee@hotmail.com
Amiral Consulting Group

PERCEIVED HARM, USE IDEATION, AND SUBSTANCE ABUSE PROGRESSION AMONG U.S. ADOLESCENTS

Influences which modulate risk perception, and its link to planned abuse, of illicit substances have not been broadly characterized. Of interest is how different factors influence harm perception at different abuse levels, and at different stages along the drug use trajectory. This study examines influences of perceived harm and planned next 12 month use of marijuana, the regarded gateway between licit and illicit drugs. A series of analyses is conducted to examine the perception-ideation relation using a combined sub-sample of 32,900 in the Monitoring The Future survey of U.S. 8th and 10th graders from 2006-08. Reconstructability analysis is applied to

identify predictors of perceived harm and interactions of different concerns regarding marijuana. Using Bayesian and Akaike criteria and a test sample, the best models of perceived harm of occasional vs. regular marijuana use yielded predictive accuracy of 82% and 92%, respectively. Of those without drug use, concerns of being around current marijuana users and the interactions between addiction with physical damage and with personal beliefs are predictive of perceived harm of occasional use. For those with lifetime marijuana use but not on any street or medical drugs, perceived harm is modulated by lower concerns for possible psychological damage, parental disapproval, peers not using marijuana, as well as by the interaction of lower concern for loss of control or lack of enjoyment. Multiple logistic regression and ROC analyses are applied to model the relationship between perceived harm and use ideation. The correlation between perception-ideation is strengthened with lifetime exposure to marijuana. In addition to perceived harm, factors including the reverse impact of school drug education, attitudes toward current users, contribute to discrimination of planned use in the next 12 months. Implications for improved risk communication and longitudinal assessments of risk perception and use ideation are discussed.

T2-E.4 Legg MN, Davidson RA, Nozick LK; rdavidso@udel.edu
University of Delaware, Cornell University

RESOURCE ALLOCATION FOR REGIONAL HURRICANE RISK MITIGATION PLANNING

Development of a comprehensive regional hurricane risk mitigation plan is difficult because it involves a large and diverse group of stakeholders; multiple competing objectives; an overwhelming number of possible mitigation alternatives; different types of spatially correlated impact (e.g., deaths, structural damage); and great uncertainty and dynamism. This paper describes a linear program designed to (1) help guide an optimal expenditure of funds for regional hurricane risk mitigation, and (2) provide insight into some of these complexities of the regional hurricane risk mitigation decision problem. Adopting the governmental perspective, the model objective is to minimize the total mitigation and expected reconstruction expenditures. Possible mitigation investments include (1) pre-event building upgrading, (2) post-event building upgrading as part of reconstruction, and (3) acquiring and demolishing buildings. A carefully defined selection of specific upgrading strategies, such as, adding hurricane shutters or bracing the gable end of a roof for wind mitigation, or elevating a structure for flood mitigation, are represented explicitly to ensure realistic representation of the costs and benefits (in terms of losses avoided) associated with each strategy. Each strategy can also be targeted to specific building types in specific locations. The hazard is represented by a carefully selected set of probabilistic hurricane scenarios that together represent both the regional wind and flood hazard. A component-based loss model was developed to estimate losses in each hurricane under each possible strategy. Because of the large number of mitigation alterna-

tives, locations, damage states, and possible hurricanes, the model is computationally intensive in realistic applications. A heuristic method was developed to solve it. The model is demonstrated through a case study for single-family residential buildings in North Carolina.

W3-D.5 Lemus R, Jackson M, Heim K, Sullivan D, Pardus M; michael.pardus@arcadis-us.com

Arcadis Inc., IIT Research Institute

DEVELOPMENT OF A SYSTEMIC LONG-TERM OCCUPATIONAL INHALATION DERIVED NO EXPOSURE EFFECT LEVEL (DNEL) FOR INSOLUBLE TUNGSTEN SUBSTANCES BASED ON A 28-DAY INHALATION TOXICITY STUDY ON TUNGSTEN BLUE OXIDE

Most exposures to tungsten (W) in occupational environments occur during production of tungsten metal from the ore and preparation of tungsten carbide powders. The most significant route of systemic exposure for workers is by inhalation of dusts. Preliminary in vitro bioaccessibility testing of several sparingly soluble tungsten substances in alveolar and lysosomal synthetic fluids (as relevant fluids for inhalation exposure) showed that tungsten blue oxide (TBO) was the most bioaccessible sparingly soluble tungsten substance (of those tested). Based on these results, TBO was chosen as the test substance for a 28-day inhalation toxicity study conducted in accordance with OECD 412 guidelines and under GLP to assess the systemic long-term toxicity of sparingly soluble tungsten compounds. In this study, 5 rats/sex/dose were given TBO nose-only, 6 hours per day, 7 days/week, for 28 days at doses of 0 (control), 80, 325, and 650 mg/m³ air. No significant adverse effects were reported at any dose level based on the clinical examinations, hematology, clinical chemistry, urinalysis, and histopathology. Therefore, the NOAEL for TBO was deemed to be greater than 650 mg/m³. The DNEL was developed according to the European Registration, Evaluation, and Authorization of Chemicals (REACH) guidelines. The NOAEL was modified to a starting dose of 330 mg TBO/m³ to account for the difference in study exposure duration (6 hrs) and anticipated worker exposure (8 hrs) and the differences in respiratory volume between standard activity (6.7 m³/person) and light activity for workers (10 m³/person). A long-term systemic inhalation DNEL of 7.3 mg TBO/m³ (5.8 mg W/m³) was calculated based on a total assessment factor of 45 to account for inter and intra species differences, and exposure duration (subacute to chronic). This DNEL is sufficiently similar to be consistent, with the current threshold limit value (TLV)-8-hour time weighted average (TWA) for tungsten (as metal and insoluble compounds) of 5 mg W/m³.

W4-F.2 Levin EA, Kocian JL, Su-Miao L, Roberts MC, Kissel JC, Meschke JS; jkissel@u.washington.edu

University of Washington

ESTIMATED RISK TO CHILDREN OF MRSA COLONIZATION FROM INTER-TIDAL BEACH SAND

Background: In pediatric populations, Methicillin Resistant *Staphylococcus aureus* (MRSA) colonization typically ranges between 0.2 - 2.2% and has been reported as high as 9.2%. Limited research has been done to identify potential reservoirs of MRSA in community settings, especially in a non-outbreak setting. Recently MRSA strains have been successfully isolated and characterized from marine water and sand samples from marine beaches in the Pacific Northwest, Hawaii, Florida, and California. Contact with beach sand and marine water has been positively correlated with disease outcomes in beachgoer populations. **Methods:** In this quantitative microbial risk assessment (QMRA), we modeled the risk of nasal colonization for children playing in the sand at the beach. A Monte-Carlo 2D probabilistic modeling approach was used to characterize the route of exposure to MRSA resulting from digging in inter-tidal beach sand. A Beta-Poisson model was utilized to predict MRSA colonization from estimated doses. Data was extracted from peer-reviewed literature (e.g. concentrations in the sand, transfer rates from the sand to the hand to the face, MRSA die-off rate, etc.), to parameterize the exposure assessment. Parameters used in the dose-response model are based on data from *S. aureus* inoculation trials in humans. **Results:** A model has been developed quantifying the risk to children ages 6-11 years after digging in the sand during a typical visit to the beach. Preliminary data predicts a median risk of colonization of 1.36×10^{-8} , with upper and lower tolerance limits of 1.23×10^{-6} and 3.57×10^{-10} , respectively. Best fit parameters for the Beta Poisson dose-response model were as follows: $\alpha = 0.2879$, $\beta = 2261.3$, and $N_{50} = 22,855$ cfu. **Conclusions:** According to our model, there is minimal risk of nasal colonization for children playing in the sand at the beach. Due to uncertainty and limitations of existing data concerning concentrations of MRSA in sand, this model may not capture the true risk of nasal colonization in children.

W4-H.4 Levine ES; evan.levine@dhs.gov

Department of Homeland Security Office of Risk Management and Analysis

LOGARITHMICALLY SCALED RISK MATRICES

Risk matrices are a common tool used throughout the public and private sector to assess and manage risk qualitatively. However, these matrices have well documented shortcomings when used for either assessment or management that can be shown by assuming a quantitative scale for the likelihood and consequence axes. This talk describes the construction of a logarithmically scaled risk assessment matrix which alleviates some of the limitations inherent in using linearly structured risk matrices. In particular, logarithmic risk matrices can better display the dynamic range of the as-

sessed risks and the categorization of risks is more straightforward. These properties are demonstrated using a hypothetical example.

P.29 Lin MH, Chen PC, Wu TN, Pan SC, Ho WC; linmh911@yahoo.com

China Medical University

EFFECTS OF OZONE AIR POLLUTION ON CARDIOVASCULAR MORTALITY IN HIGHLY URBANIZATION CITY

Ozone air pollution on health in recent years has been an important public health issue. Indeed, several epidemiologic studies have pointed out that there is an association between particulate matter (PM) and ozone (O₃) and the increased incidence of cardiovascular morbidity and mortality. Most of the evidence comes from studies of ambient particles concentrations; however, few reports investigate the relationships between O₃ and cardiovascular morbidity and mortality. The objective of this study is to assess the associations between O₃ and cardiovascular mortality in highly urbanization city. This study was conducted in which a total of 1,030,090 population who lived in six townships of Taipei City, Taiwan. Mortality data were obtained from Taiwan Death Registry (TDR) provided by the Department of Health (DOH). The monthly mortality was calculated and linked air pollutant concentrations that provided by the Environmental Protection Administration (EPA). The standardized mortality ratio (SMR) was calculated to estimate the relative risks of all cardiovascular causes and disease-specific mortality after adjusted by gender, age, season, PM_{2.5}, temperature and relative humidity. The total number of death due to cardiovascular diseases (ICD-9: 390-459) was 3,999 during 2006-2008. Two major site-specific mortality were ischemic heart disease (ICD-9: 410-414, n=975) and cerebrovascular disease (ICD-9: 430-438, n=1,617). The relative risks for cardiovascular diseases were significant in cool season and warm season (RR, 1.17; 95% CI, 1.08 to 1.26; and RR, 1.09; 95% CI, 1.06 to 1.11, respectively). Furthermore, an increased association between cerebrovascular disease and O₃ was also observed in cool season and warm season (RR, 1.22; 95% CI, 1.15 to 1.30; and RR, 1.10; 95% CI, 1.04 to 1.16, respectively). This study confirms that long-term O₃ exposure is related to cardiovascular mortality after considered PM_{2.5} and potential risk factors in highly urbanization city.

P.30 Lin M, Wu K-Y; kuenyuhwu@ntu.edu.tw

National Taiwan University

PROBABILISTIC CANCER RISK ASSESSMENT FOR DIMETHYLARSINIC ACID FROM DAILY CONSUMPTION OF FRYING OIL OF FAST FOOD IN TAIWAN

Exposure to arsenic is shown to cause cancer especially in the lung, skin, and urinary bladder. On June 22, 2009, arsenic was reported present in the frying oils of some fast food restaurants in Taiwan. Further studies show that the arsenic was contributed by dimethylarsinic acid (DMA) after analysis of 164 frying oil samples.

DMA was demonstrated to be a carcinogen for the rat urinary bladder, generation of oxidative DNA damage might play an important in DMA carcinogenesis. Due to the potential exposure to DMA by dining at these fast food restaurants, the health risk has been of great concerns. Therefore, the objective of this study was to conduct a probabilistic assessment of cancer risk for DMA from consumption of frying oil in fast foods. The cancer slope factor was calculated by using the best fit BMDL10 based on outputs from 10 dose-response modeling by using the benchmark dose software and extrapolated from animal to humans. Monte Carlo simulation was run for 5000 trials to perform probabilistic cancer risk assessment by assuming lognormal distributions for the daily consumption rate of frying oil with a mean at 11 g/day with coefficient of variation (CV) at 10%, DMA contents with a mean at 0.002 ppm with CV at 10%, and Taiwanese body weights with a mean at 60 kg with CV at 50%. Exposure duration was assumed equal to average time, and exposure frequency was assumed to be 1. The mean cancer risk was estimated 3.62×10^{-8} and the upper bound of 95% confidence interval of cancer risk was 7.04×10^{-8} . These results suggest that exposure to DMA in the frying oils of fast food restaurants in Taiwan is not likely to cause a significant increase in cancer risk at the mean DMA concentration of 0.002 ppm.

M4-H.1 Linkov I, Canis L, Zan K, Trump B, Keisler J; igor.linkov@usace.army.mil

US Army Engineer Research and Development Center

APPLICATIONS OF VALUE OF INFORMATION ANALYSIS: REVIEW OF THE LITERATURE SINCE 1990

Value of Information (VoI) analysis is a method that quantifies the value of acquiring additional information for informing decisions. Since its incorporation in decision-making in the late 1960s, VoI has been applied in many settings. This presentation reviews and summarizes application trends for papers published since 1990. The nonexhaustive literature review of VoI application trends included an analysis of the Science Citation Index (SCI) database available through the Web of Science. This database provides access to articles and published abstracts from over 6000 scholarly journals. Through a series of queries and screening, about 200 papers were identified for a detailed review. The published literature review was supplemented by (i) the Google search engine, used to locate gray literature and (ii) references cited in review articles and original articles identified through the SCI database. We will report temporal pattern for VoI application as well as statistics for VoI use in different application areas.

T3-C.2 Liu C, Lavell J, Allen M, Wakeman J; liush@cdm.com
CDM

INTEGRATING MULTIPLE LINES OF EVIDENCE FOR RISK EVALUATION

Quantitative risk assessments often assume that health risk is a result of site-related releases to the environment. This assumption is not always true. In this study, the risk assessment for fish consumption for anglers is evaluated by integrating multiple lines of evidence (MLOE) into quantitative risk estimations. Lines of evidence used are fish tissue screening levels, sediment and fish data from the reference area, historic data, dioxin homolog profiles, and chemical concentrations in fish samples collected from the region. Quantitative risk analyses suggest potentially high risks associated with consumption of fish taken from the aquatic area. The MLOE approach is used to determine whether such high risks are related to releases from the site. Results of the MLOE approached are as follows: First, the highest risks are associated with arsenic in fish tissue, yet arsenic is present only at levels typical of local background. Second, the only other chemicals that contribute significantly to angler risks are dioxins. The comparison of the reference area and the site suggests that concentrations of dioxins and homolog profiles do not differ between the two areas. Third, dioxin concentrations in fish tissues collected at the site are entirely consistent with the range of concentrations reported in the lower Columbia River. Fourth, concentrations of chemicals of potential concern (COPCs) in sediments at the site have been declining since the mid-1990s. This trend reflects the general trend in the lower Columbia River and is consistent with deposition of sediments with lower chemical concentrations over time. Fifth, detected concentrations of DDT, lead, and mercury do not exceed the state screening levels. In conclusion, quantitative risk analyses suggest potentially high risks associated with consumption of fish taken from the aquatic area. The MLOE approach, however, indicates that such high risks are unlikely to be related to releases from the site.

T4-E.3 Liu X, Frey HC; frey@ncsu.edu
North Carolina State University

APPORTIONMENT OF HUMAN EXPOSURE TO AMBIENT AND INDOOR SOURCES OF FINE PARTICULATE MATTER

The U.S. Environmental Protection Agency (EPA) is reviewing the current National Ambient Air Quality Standard (NAAQS) for particulate matter, including fine particulate matter (PM_{2.5}). In a March 2010 draft policy assessment, EPA concludes that “consideration should be given to revising the current PM_{2.5} primary standards.” EPA is revising the policy assessment on a path toward proposing a revised standard. Current health effects assessments are primarily based on epidemiological assessment of the relationship between ambient concentration and response, where ambient concentration is used as a surrogate for exposure. Health effects may

differ depending on the chemical composition of fine particles, but most health effects studies are based on total mass of the particles. Therefore, there is a need to develop and demonstrate methods for quantifying human exposure to fine particulate matter, and differentiating exposures with respect to the origin of ambient and non-ambient particles. The chemical composition of particles differs depending on their origin, such as primary emissions from combustion, fugitive emissions, secondary formation of sulfate and nitrate aerosols, and indoor sources such as cooking, smoking, and cleaning. Here, we demonstrate the synthesis of receptor-based air quality modeling approaches for source apportionment of monitored ambient fine particles with a simulation-based microenvironmental model of inter-individual and temporal variability in exposure to apportion non-ambient exposures. The results enable characterization of the proportion of the total PM_{2.5} mass exposure concentrations among ambient and non-ambient source categories. The methodology is demonstrated for a detailed case study of a specific geographic region. The results illustrate that exposure has more variability than ambient concentration, and that the relative importance of specific exposure sources varies depending on demographic and geographic factors, and with time.

T2-E.3 Liu Z, Pita GL, Francis R, Mitrani-Reiser J, Guikema SD, Pinelli JP; liuzhang.1983@gmail.com

Johns Hopkins University, Florida Institute of Technology

IMPUTATION MODELS FOR USE IN HURRICANE BUILDING-RISK ANALYSIS

Hurricanes make landfall in the United States a couple of times per year. These windstorms may cause huge building losses and severely endanger public safety. The cumulative damage caused by frequent, less-intense events cannot be ignored. Additionally, with the rapid increase in population and wealth in coastal regions, it is necessary to build accurate catastrophe models for predicting the expected building damage caused by hurricanes. These models are also helpful in deciding how to allocate limited hazard mitigation funds. An important step in developing these hurricane risk models is to accurately assess the vulnerability of regional building stocks. In developing the risk models, there are some key building features (e.g. year built, roof type, roof cover material, exterior wall material, etc.) that are used as input, and that influence significantly the accuracy of the building vulnerability estimation. However, it is often difficult to acquire complete information of building features from public available records. This study examines several data imputation approaches to handle missing building information and validates their accuracy using holdout testing. This paper evaluates the effectiveness of using statistical models to predict a single building characteristic (roof type) based on the dataset from one county in the state of Florida. The predictions from different techniques are compared, including General Linear Models (GLMs), General Additive Models (GAMs), Multivariate Adaptive

Regression Splines (MARS), Classification and Regression Tree (CART), Bayesian Additive Regression Tree (BART) and Average Model. The paper also gives recommendations on the use of these models in regional-natural hazard risk assessment.

P.111 Liu Y, Wu F; yal27@pitt.edu

University of Pittsburgh

AFLATOXIN AND POPULATION ATTRIBUTABLE LIVER CANCER RISK: INSIGHTS FROM BIOMARKERS IN MULTIPLE EPIDEMIOLOGICAL STUDIES

Aflatoxins are secondary metabolites produced by the fungi *Aspergillus flavus* and *Aspergillus parasiticus*, which infect crops such as corn, peanuts, and tree nuts. Aflatoxin B₁ (AFB₁) is the most toxic of the aflatoxins, and is common in food in Southeast Asia, China, and Sub-Saharan Africa. These world regions also suffer the highest hepatitis B virus (HBV) infection rates and hepatocellular carcinoma (HCC) incidence. AFB₁ exposures from the dietary food are believed to be casually associated with the HCC in these populations and the evidence is already well documented. However, the population attributable risk of liver cancer from aflatoxin remains unclear. In this study we address this knowledge gap by calculating the population-attributable risk (PAR) fractions of dietary AFB₁, individually and in combination with chronic HBV infection, in causing HCC in varied world regions. We compiled the relative risks or odds ratios of AFB₁ in relation to HCC from multiple epidemiological studies, determined the proportion of populations exposed to AFB₁ in these areas and then calculated the population attributable risk of aflatoxin in these study populations. Thus, we can quantitatively determine how many HCC incidences could be prevented in 1) populations regardless of HBV carrier status; 2) HBV carriers; and 3) HBV negative populations, if aflatoxin exposure could be reduced to undetectable levels. This study highlights how the use of validated biomarkers to link health outcomes and exposure can be applied to risk assessment. Moreover, our results will provide insights for policy makers to determine the importance of reducing AFB₁ dietary exposure to non-detectable levels in various populations.

W4-C.2 Lizarazo JJ, Cardenas CA, Muñoz F; jon-liza@uniandes.edu.co

Andes University

SAFETY CONCERNS VALUATION IN BIOFUELS OVERALL PROCESSES: NEW CONCERNS AND MITIGATION RISK PROTOCOL HANDLING WITH ALTERNATIVE FUELS.

The importance of Biofuels as a new energy source has supported and developed the interest in the study and characterization of different methods, processes and raw materials that are enrolled in its production. However, the risk associated to the overall production process has not been considered such a significant barrier in the sustainability and development of alternative fuels. Multiple industrial accidents have occurred in Biofuels production, including explosions and fires that affect the

safety of the processes, showing that the risk valuation must be an important concern. Focusing in ethanol production process from sugar cane and biodiesel production process from palm oil, a safety and risk valuation program has been proposed. It will give a preliminary risk measure to be considered according to different process scenarios established and fixed by the user depending in its production and design requirements. Once the valuation has been completed, some possible scenarios are proposed as an example for developing a standard safety protocol. This protocol is the key to mitigate the risk of the biofuel production chain. Additionally, the consequences of a bad protocol are established in order to know the affectation scale and effects of an incident in the process chain.

M4-F.5 Lofstedt R; ragnar.lofstedt@kcl.ac.uk

Kings College London

RISK MANAGEMENT IN THE ERA OF PUBLIC DISTRUST

The communication and regulation of risk has changed significantly over the past 30 years in both Europe and the United States partially as a result of regulatory scandals ranging from mad cow (BSE) to Vioxx, which have led to greater public distrust of regulators and policy makers. In this talk the author examines, via three case studies, one of the regulatory consequences of such scandals, namely the move from risk assessment to hazard assessment in the United States. The cases selected for this analysis are acrylamide, bisphenol A, and artificial food colourings, all of which have been in the news over the past few years. In the final section he offers some recommendations for how the FDA and other scientific based regulators can best handle these types of “hazard” scares. The study is based on a review of both the academic and grey literatures, a content analysis of a select number of US broad sheets over the past three years, and formal as well as informal interviews with regulators, stakeholders and academics in the United States.

T4-B.2 Long TC, Ogilvie-Hendren C, Gwinn M, Davis JM; long.tom@epa.gov

US Environmental Protection Agency

RESEARCH PRIORITIES FOR COMPREHENSIVE ENVIRONMENTAL ASSESSMENTS OF NANOMATERIALS: FOCUS ON SILVER NANOPARTICLES IN SPRAY DISINFECTANTS

As part of a nanomaterials research strategy and in an effort to support future nanomaterial assessments, U.S. EPA is systematically identifying information gaps through the development of a series of case studies on specific nanomaterial applications. The case studies use a comprehensive environmental assessment (CEA) approach, which encompasses the product life cycle, fate and transport, exposure-dose, and health and ecological effects. The case study described herein considers the use of silver nanoparticles (nano-Ag) in disinfectant sprays. The manufacture and use of these sprays could result in nano-Ag entering the environment via various pathways, e.g. through cleaning processes. Environmental fate and transport processes include

the potential for oxidation of nano-Ag particles to form silver ions and for sorption of particles or ions to soils and sediments. Particle surface coatings and other spray constituents may modify the environmental behavior of nano-Ag. Use of nano-Ag sprays might lead to human exposure through inhalation, dermal contact, or ingestion via hand-to-mouth transfer. Although some evidence exists for ecological and health effects of nano-Ag, data gaps remain. These include: determining the adequacy of existing methods for evaluating toxicity; evaluating the relative importance of nano-Ag and silver ions, both for fate and transport and for ecological and health effects; and determining the appropriate metrics for characterizing nano-Ag. These and other information gaps are noted in the form of questions listed throughout the draft case study document. The case study is part of a process EPA is using to help identify and prioritize research directions that will support future CEAs of nanomaterials such as nano-Ag. Research priorities identified through a structured workshop, currently scheduled for Fall 2010, will be highlighted. Disclaimer: This abstract does not necessarily reflect the views or policies of U.S. EPA.

W2-F.1 Longstaff H, McDonald M, Bailey J; longstaf@interchange.ubc.ca

The University of British Columbia

COMMUNICATING RISKS AND BENEFITS ABOUT CONTENTIOUS HEALTH TOPICS: THE CASE OF HUMAN INDUCED PLURIPOTENT STEM (IPS) CELLS

The study described in this paper is intended to provide the Canadian Stem Cell Network (SCN) with a powerful method for in-depth two-way communication with the public and expert communities about complex and sensitive issues at the heart of stem cell (SC) research. The fundamental objective is to raise awareness of SC science with lay citizens by fostering ethical decision making through an online risk communication experiment. The experiment tests the effectiveness of structured decision making (SDM) to foster ethical policy decisions and also tests different methods of communicating a range of information about human induced pluripotent stem (iPS) cells. The topic of iPS cells was identified as a significant issue during our previously funded SCN ethics education study and data collected from this study was used to inform our experiment. The results from this study should be of interest to all those engaged in decision analysis, risk communication, public opinion, and policy related to stem cell research. The study described in this paper is currently underway at The W. Maurice Young Centre for Applied Ethics at The University of British Columbia and funded by the Canadian Stem Cell Network.

T3-A.2 Lopez-Jurado FB; fljurado@unav.es
University of Navarra

THE ROLE OF SCIENCE IN RISK MANAGEMENT REGULATION IN THE EU: LICENSING AND SUPERVISION OF MEDICINAL PRODUCTS

Interesting conclusions can be derived from the analysis of the influence of science on EU case law and in the adjudication performed by the EU Commission. Although decision making in risk related situations should always be based on reliable science, other factors and considerations are also taken into account by the EU Court of Justice and by the EU Commission. Further more, the role played by science in administrative adjudication is different from its influence in judicial review. The conclusions obtained from the EU regulation of medicinal products can be applied to other risk related fields.

P82 Lundell HC; hcb45@cornell.edu
Cornell University

PREVENTION AND EARLY DETECTION ON THE ROAD: APPLYING THE RISK INFORMATION SEEKING AND PROCESSING MODEL TO HEALTH INFORMATION ROADSHOWS

Health information “road shows” comprise a mobile space travelling between towns, bearing health communicators and informational resources. Originating from the concept of ‘experiential marketing’ of consumer products, the road show format is growing in popularity as a method of promoting prevention and early detection of diseases including diabetes, heart disease and cancer. In particular, road shows have been earmarked as a effective means of reaching low SES populations; however, there is little research assessing their effectiveness and none proposing a theoretical framework for future research. Drawing on experience working with a road show organized by a prominent charity in England, this paper proposes utilizing Griffin, Neuwirth and Dunwoody’s (1999) Risk Information Seeking and Processing model to analyze the impact of health information road shows, conceptualizing them as interventions whose goal is to influence visitors’ health information seeking and processing behaviors. Furthermore, this paper considers whether theories from consumer behavior research may be able to offer further insight into risk information seeking in this context, by asking whether a road show may inspire ‘impulsive,’ risk information seeking due to the shows’ ‘time limited’ nature. Ultimately, informed by theoretical perspectives described above and by the experiences of those managing road shows, we consider: 1) Why might (or might not) someone, particularly of low SES, use a road show as a source of health information?; and 2) Why might (or might not) the road show model be particularly adept at positively influencing information seeking and health behaviours, at the time of the intervention and beyond? Theoretical and practical implications are discussed.

T4-B.1 Luoma SN; snluoma@usgs.gov
University of California, Davis

ENVIRONMENTAL IMPLICATIONS OF NANOSILVER IN THE ENVIRONMENT

The anti-bacterial properties of silver are well known. Nanotechnologies exploit these properties in novel applications, providing important potential benefits in areas like medical devices and water purification. Consumer products with more questionable benefits are also proliferating, with the potential that hundreds of such products could be used by millions of people. Several well studied instances show serious adverse ecological effects occurred from the historic releases of silver from a technology that was widely used (traditional photography). Nanoparticles of silver add to the risk from silver itself. Commercial uses of nanosilver will result in exposure of humans and animals to a form of silver, the nanoparticle, with which our biological systems have little or no evolutionary experience. A growing body of evidence suggests some forms of nanosilver can be very persistent in aquatic environments (citrate-capped particles). If silver nanoparticles persist, one likely fate is release from consumer products into human food or association with materials that will be ingested by animals as a result of aggregation, trapping in natural particles or uptake by plants. A recent study suggests that nanosilver is retained efficiently when ingested with food by animals, but work on this question is only beginning. There is also evidence that nanosilver can be toxic to some aquatic animals at startlingly low concentrations. If nanosilver is an environmental hazard then risks will be defined by loads to the environment. But lack of reporting requirements for nanosilver products, and lack of information on the concentration and characteristics of the silver nanoparticles (particle size, capping agent, shape) make analysis of this aspect of risk difficult. Registration, comprehensive evaluation of hazards specific to the silver nanoparticle, and authorization of specific uses could all be a part of a regulatory strategy for this proliferating technology.

T4-G.4 MacDonell M, Davidson A, Finster M, Scofield M, Peshlov B; macdonell@anl.gov
Argonne National Laboratory

STATE CLEANUP LEVELS FOR DIOXIN INFORM DRAFT INTERIM PRELIMINARY REMEDIATION GOAL

More than 10 years ago, U.S. EPA identified a concentration of dioxin in soil as a starting point for setting cleanup levels. Scientific data on exposures and effects has continued to evolve. To inform an interim preliminary remediation goal (PRG), EPA pursued data on cleanup levels and their scientific bases across all 50 states, Washington DC, and 6 island territories. Nearly half have established a cleanup level or guideline, and another quarter have identified screening levels. The rest call for site-specific determinations, for which insights were pursued from cleanup records

of decision. About 280 values were found, with some agencies listing multiple concentrations per different land uses. These cleanup levels span three orders of magnitude, reflecting differences in (1) exposure assumptions, (2) reporting basis (TCDD or TEQ), (3) toxicity value, (4) target risk, and (5) adoption vs. derivation. Most levels for residential/unrestricted use fall at or below 120 ppt; all are based on cancer, and over half reflect a 1985 EPA slope factor. Exposure is a central element of cleanup-level calculations; since states usually establish values for many chemicals, a generic equation is used that was found to be similar across agencies. For dioxin, incidental ingestion is the dominant exposure route for unrestricted/residential use, and 4 states use this as the sole basis for their cleanup levels. (Most others incorporate inhalation and/or dermal exposures but contributions are small except for some scenarios, e.g., excavation workers.) In calculations for this route, exposure frequency differs by about 2.4 fold, the soil ingestion factor by nearly 3 fold, the slope factor by about 20 fold, and target risk by 100-fold. This first-ever systematic identification and evaluation of cleanup levels in use across the U.S. provided context for EPA's January 2010 draft guidance for a recommended preliminary interim PRG, to be further informed by more recent dose-response analyses.

M4-E.4 MacKenzie CA, Barker K; cmackenzie@ou.edu
University of Oklahoma

INTEGRATING SIMULATION WITH RISK-BASED INTERDEPENDENCY MODELING TO EVALUATE THE CONSEQUENCES OF AN INLAND WATERWAY PORT CLOSURE

We build a simulation to model companies' decisions after an inland waterway port suddenly closes. Simulation helps us determine how a company might react to a port closure, and each company becomes an individual in the simulation. We integrate the results of the simulation into a risk-based input-output model in order to evaluate the interdependent effects of those companies' decisions. In the simulation, each company who uses the port decides whether to ship its product via an alternate transportation mode, like truck or rail, or wait for the port to open. If the company waits for the port to open, we use the Dynamic Inoperability Input-Output Model to evaluate the economic effects of product not reaching its customers on time. We deploy this simulation and model to examine the interdependent effects of closing the port of Catoosa in northeastern Oklahoma for one to two months. The simulation requires a schedule of daily shipments into and out of the port of Catoosa, and we estimate a daily schedule for the port by combining publicly available databases. Simulation results show that loss in production is heavily dependent on companies' actions. We discuss the implications of our results for policymakers.

T4-H.2 MacLean LC, Richman A; l.c.maclea@dal.ca
Dalhousie University, Canada

AGGREGATE RISK MEASURES AND RISK AVERSION

Complex systems are subject to failure with increased use and degradation. The risk process is the stochastic dynamic process of system failures and their severities. This paper considers aggregate risk measures for the risk process of complex systems in the context of stochastic ordering. The aggregation follows from the accumulation of losses from a series of failure incidents. The emphasis is on second order risk measures which account for risk aversion as defined by concave utilities. A second order measure termed the Adjusted Risk Priority Number (ARPN) is presented. The measure is constructed from well known statistics: rate of failures, expected severity of failures, and the Gini Index for severity of failures. The ARPN is contrasted with the traditional Risk Priority Number (RPN) defined by the rate and expected severity. The computation and use of the measures is illustrated with failure data from airport navigation systems in North America.

T2-B.2 Magnuson BA; bmagnuson@cantox.com
Cantox Health Sciences Intl

CRITICAL EVALUATION OF SCIENTIFIC LITERATURE ON THE ORAL TOXICITY OF NANOMATERIALS

Ingestion of nanoparticles is an everyday occurrence due to the presence of naturally occurring nanoparticles in foods. Oral exposure to engineered nanomaterials may result from either contamination of food with engineered nanomaterials developed for use by other industries or from engineered nanomaterials designed for use as food ingredients and/or for use in food production and packaging. The desired and unwanted (i.e., toxic) biological activities of engineered nanomaterials have been a focus of research efforts worldwide and are being reported at an exponential rate. Unfortunately, the literature is fraught with examples of studies that have serious limitations. To assist with the design and interpretation of studies that examine the biological activity of nanomaterials that may be used in the food industry, we developed a two-step method to assess and rank their overall quality. The first step involves the utilization of a publicly available tool to rank the reliability of a given study based on the adequacy of its design and of its documentation of methods, materials and results. The second step involves the determination of the completeness and reporting of the physicochemical characterization of the nanomaterial that is being assessed within the study. The results of an assessment of 30 published studies on oral toxicity of nanomaterials utilizing this method found that most studies reported insufficient data regarding the characterization of the nanomaterial, were of short duration, and/or were lacking critical experimental design considerations. The results of this evaluation indicate that to allow clear assessment of the safety of oral exposure to food-related nanomaterials, significant investment must be made

to generate studies of sufficient quality and duration and that report comprehensive nanomaterial characterization.

P40 Makino R, Fuse M, Yamazaki M; ryojy-makino@aist.go.jp

National Institute of Advanced Industrial Science and Technology

POLICY-INDUCED RISK TRANSFER OF LEAD IN ASIA: AN ANALYSIS USING THE COMBINATION OF THE COMPUTATIONAL GENERAL EQUILIBRIUM MODEL AND THE MATERIAL FLOW MODEL

In Asia, there have been serious problems of health hazards and environmental pollutions associated with lead at the secondary refining (recycle) sites in some countries. The lead pollution level of each country might be affected by the environment-related regulations. If each country adopted its own lead-related regulations without any international coordination, it might result in “risk transfer” among the countries, which means alteration of risk level due to the change of emission amount because of the regulation change. This could cause the international conflict. In this study, we simulate how various combinations of economic policies and environmental policies of each Asian country affect the international distribution of health and environmental risk of lead by using the computational general equilibrium (CGE) model based on economics and the material flow model. The CGE model can simulate the variation of the aggregate (national level) economic variables when the combination of hypothetical policies is implemented. We focus the variation of the production volume of the secondary refined lead of each country, which is seen as significant emission source. Using the results of the CGE model, the material flow model can estimate the variation of the emissions at the 1st mesh level including those from the informal sector, which cause the variation of the risk. This study contributes to the quantification of the policy-induced international risk transfer by combining the economic model and the material flow model. An international policy coordination might be needed in order to improve the distribution of risk, that means to realize some kind of equality, subject to a given risk level in the whole Asia. This study provides the valuable information for environmental policy makers to establish the scheme to recycle lead internationally managing the level and distribution of risk of lead.

M3-D.4 Marks BP; marksbp@msu.edu

Michigan State University

VARIABILITY AND UNCERTAINTY IN PASTEURIZATION VALIDATION METHODS FOR LOW MOISTURE FOODS

Low-moisture food products present a particularly vexing challenge, relative to microbial safety, as reflected in recent nationwide outbreaks and/or recalls associated with *Salmonella* in a variety of these products. In particular, processors of low-moisture products currently have no way to know which pasteurization validation method yields the most accurate or reliable results, or the margin of safety necessary

for a given system. Two critical technical gaps are: (1) How to reliably monitor the critical process parameters and account for them in lethality calculations, and (2) How to quantify uncertainty associated with either surrogate-based test results or model-based lethality calculations, and account for that uncertainty in validating/ensuring process efficacy. To demonstrate the impact of such factors on computed process outcomes, we have used dry/moist-air heating of almonds as a test case, in which we have quantified the accuracy and repeatability of four lethality validation methods (3 based on different temperature measurement strategies and 1 based on a non-pathogenic bacterial surrogate), as compared against *Salmonella Enteritidis* PT30-inoculated challenge studies in a pilot-scale oven system. No single method yielded both the best accuracy and best repeatability. Additionally, accuracy of lethality calculations based on a given temperature measurement method can be affected significantly by the process conditions (e.g., air velocity). Overall, regardless of the method employed for validating pasteurization processes for low-moisture foods, it is critically important that the lethality calculation or risk analysis accounts for the inherent uncertainty in the measurements upon which the methods depend.

M2-C.4 Marlatt HL, Trumbo CW; holly.marlatt@colostate.edu

Colorado State University

RISK COMMUNICATION AND ISSUE ACTIVATION: THE EFFECT OF RISK PERCEPTION AND INFORMATION EFFECTS ON COMMUNITY MEMBERS' ACTIONS TOWARD A PROPOSED URANIUM MINE

This study investigates how risk perception and information effects may influence the degree to which individuals become active concerning a putative industrial-environmental hazard. The context of the investigation centers on a proposed in-situ uranium mining operation near Nunn, CO. Conceptually, the investigation models “issue activation,” which is drawn from the public relations literature. Data were collected in 2009 using a mail survey sent to households within 15 miles of the proposed mine (50% response, $n = 203$). The questionnaire included a measure of issue activation as an index of five activities that individuals might have taken concerning the strong debate of the mine’s approval (writing letters to the editor, attending public meetings, etc.), items on information seeking and attention on the issue, and the perceived usefulness of five information channels (e.g., newspapers, web, friends). A multiple regression analysis was employed to predict participants’ actions taken concerning the proposed mining operation. A significant model emerged ($R\text{-square} = .51$, $p < .001$). The significant predictors of actions taken concerning the proposed mine were risk perception ($\beta = .023$, $p = .056$), television as a media source for information ($\beta = -.179$, $p < .000$), Internet as a media source for information ($\beta = .096$, $p < .05$), information seeking ($\beta = .420$, $p < .000$), and information exposure ($\beta = .263$, $p < .000$). These results suggest that individuals

who had been most active on the mining issue have significantly higher perceptions of risk from the mining operation, have been exposed to more information about the issue, more actively seek information about the issue, and have significantly relied on television the least and the Internet the most; conversely, those who have been least active have relied on the Internet the least and television the most. The results suggest that the intensive Internet-based efforts by mining opponents have been effective.

P.34 Martin LR, Gallagher K; martin.lawrence@epa.gov

US Environmental Protection Agency

EPA RISK ASSESSMENT FORUM ECOLOGICAL OVERSIGHT COMMITTEE

The Risk Assessment Forum initiated two new projects in 2010. (1) Incorporating Ecosystem Service Endpoints into EPA's Ecological Risk Assessments: Presently, Ecological Risk Assessments (ERAs) use endpoints based on protecting properties of nonhuman organisms, populations and ecosystems, as described in the Risk Assessment Forum's Report, Generic Ecological Assessment Endpoints (GEAEs) for Ecological Risk Assessment. Ecosystem services are defined as the products of ecological functions and processes that directly or indirectly contribute to human well being. The Forum's GEAE's do not include ecosystem services, and the extrapolation from ecological properties to services is not described. Incorporating ecosystem service endpoints into ERA will benefit EPA and the risk assessment community by improving risk communication and risk management decisions. (2) Enhancing the Utility of Ecological Risk Assessment Information in Decision Making: An exploration of why the results of ERAs have not had the impact on Agency decision making anticipated. The use of ecological risk assessment results is not consistent across programs and the results are not having the impact expected on decision making. Recent reports from the EPA Science Advisory Board (October 2007) and NRC (2008) urge the Agency to make better use of ecological risk assessment findings. Guidance to risk assessors and decision makers will be generated on how to better communicate and enhance the use of ERA information in Agency decision making.

P.4 Masinter AM; amasinte@andrew.cmu.edu

Carnegie Mellon University

AN INTEGRATED KNOWLEDGE STATE MODEL FOR PRIORITIZING COMPLEX MULTIDISCIPLINARY RESEARCH PORTFOLIOS

Understanding the environmental and health risks of nanotechnology is currently the focus of a large number of U.S. laboratories and international consortia. Previous efforts by research funding agencies to prioritize research topics in this area have been criticized as lacking in rigor and objectivity; however, the criteria for developing optimal research portfolios are far from obvious. All models of environmental nanomaterial risk reflect the interconnected event chain from nanomaterial emission to ecological and health effects. The linked and branched structure of the

event chain implies that knowledge derived in one element of the system can change the knowledge of elements upstream and downstream of it. Here we construct a Bayesian Belief network (BBN) model for research prioritization for silver nanoparticle risk research, through a combination of literature and proposal review, along with expert elicitation. Nodes in the BBN may consist of hypotheses, projects, and areas of understanding. These nodes have two or more probabilistic states corresponding to the truth of the hypothesis, possible outcomes of the research, and the sufficiency of understanding of a particular knowledge domain. The model is parameterized by the specification of the conditional probabilities of node states given the states of their parent nodes. For instance, the probability of a certain project outcome is conditional upon the truth states of one or more hypotheses. The model is used to generate research portfolios representing a variety of explicit research objectives, e.g., to maximize the expected value of information for a specific budget constraint. This method will aid research consortia and funding agencies in constructing research portfolios more objectively reflective of their institutional goals.

W1-F.7 Mathers JJ; jeremy.mathers@alpharma.com

Alpharma, LLC

PROPORTION AND ALLOMETRIC SCALING ESTIMATES OF U.S. FOOD-PRODUCING ANIMALS VERSUS PEOPLE: IMPLICATIONS ON POTENTIAL ANTIMICROBIAL RESISTANCE RISKS

Data on major livestock and poultry species processed for meat in the year 2008 (USDA) were tabulated along with comparable human statistics (U.S. Census and other). Per capita and per live weight ratios of food animal vs. humans were established, along with allometric scaling comparisons used to estimate an animal sector antimicrobial dosage. Per capita, there were 31.2 X and by weight 3.4 X more food producing animals versus people. Animals therefore made up 77% of the total weight of animals plus people. Using allometric Kleiber (exponential) and linear scaling along with weight proportions for each major species, suggested food producing animal doses relative to one human dose were calculated. Ratios of 2.26:1 (69%) and 3.69:1 (79%) were the suggested allocated proportions of total antimicrobials to food producing animals using Kleiber and linear methods, respectively. The computed allocations are somewhat higher than other estimates of total antimicrobials used in food producing animals (~50-70%). About 40% of reported agricultural antimicrobials are in classes with no identified resistance hazard (such as ionophores). The actual percentage of antimicrobials with resistance risk potential given to U.S. food-producing animals is therefore considerably lower than scaling models or other estimates suggest.

T3-B.3 Maynard AD; maynarda@umich.edu

University of Michigan

EMERGING TECHNOLOGIES - EMERGENT RISKS: SEPARATING THE WHEAT FROM THE CHAFF

The dexterity with which we can manipulate matter at the nanoscale to create new technologies and enhance established ones is progressing in leaps and bounds. Amongst other areas, the resulting nanoscale science and technology holds great promise for enhancing food-related products by improving production processes, packaging, sensing technologies and food additives. Yet the adoption and development of these technologies is being slowed by uncertainty over how to ensure their safe use, and how to provide credible, trustworthy and accessible information on product safety. These challenges are made more complex by the historic use of nanoscale components in some food products, and the inherent nanoscale nature of many biological processes associated with ingestion. If safe and sustainable uses of nanoscale technologies in food products are to be developed, there needs to be a shift in thinking toward risk-focused problem formulation that is firmly grounded in science. Yet despite recent advances, researchers are still struggling to identify relevant risk-based questions, to generate meaningful data and to underpin informed decision-making regarding the use of nanoscale science and technology in the food sector. This is due in part to an adherence to definitions of nanotechnology and nanomaterials that are better suited to promoting innovation rather than informing effective risk research. Looking forward, there is a need to move away from definitions that inhibit effective problem formulation and towards principles that help differentiate “new” risks from those that can be addressed through conventional approaches. In this context, a “principle of plausible, emergent and substantial risk” is proposed to underpin science-informed and socially-relevant research towards safe uses of nanoscale technologies in food products.

W3-B.4 McComas KA; kam19@cornell.edu

Cornell University

RESEARCHER VIEWS ABOUT FUNDING SOURCES AND CONFLICTS OF INTEREST IN NANOTECHNOLOGY

Dependence in nanotechnology on external funding and academic-industry relationships has led to questions concerning its influence on research directions, as well as the potential for conflicts of interest to arise and impact scientific integrity and public trust. Research has shown, for example, that when people believe scientists have conflicts of interest, they also view those scientists as less trustworthy. This study uses a survey of 193 nanotechnology industry and academic researchers to explore whether these researchers share similar concerns about funding and conflicts of interest. Although these concerns are neither new nor unique to nanotechnology, its emerging nature and prominence lend credence to understanding its researchers’

views, as these researchers are shaping the norms and direction of the field. The findings show general agreement that funding sources influence research directions in nanotechnology; many respondents saw this influence in their own work as well as other researchers. Respondents also agreed that funding considerations were likely to influence whether researchers shared their results. Only 11% of respondents indicated that financial conflicts of interest were uncommon in nanotechnology whereas 44% considered them a cause for concern. Only a third was satisfied with the way that conflicts of interest are managed or believed current procedures would protect the integrity of nanotechnology research. Differences between academic and industry respondents related to the perceived influence of financial interests on researchers’ behaviors, as well as the extent to which respondents were aware or believed that procedures were in place to manage conflicts of interest.

P.41 McDowell RM, Neeley AD; robert.m.mcdowell@usda.gov

US Department of Agriculture

COMPUTABLE GENERAL EQUILIBRIUM MODELS TO IMPROVE CONSEQUENCE ESTIMATION IN BIO-CLIMATIC RISK ANALYSIS

As the evidence accumulates for wide ranging effects on agro-ecosystems from climate change, the application of methods capable of realistically estimating the economic consequences of such changes have not kept pace with developments in climate modeling. The techniques most frequently used to estimate economic impacts in pest risk assessments are partial budgeting and, rarely, partial equilibrium analysis. These approaches make relatively few data demands but fail to generate output incorporating economic linkages between various economic sectors, nor do they account for spill-over or secondary effects. Modern computable general equilibrium models are expensive to develop and maintain but are the only approach that can make realistic and comprehensive estimates of the true economic impacts, on both producers and consumers, of external shocks, voluntary policy changes, or new cropping/market opportunities such as biofuel production. We illustrate the function of the models and their application to estimating the economic impact of invasive agricultural pests as climate changes, highlighting the additional information this approach provides compared to less rigorous methods. A proper and full economic accounting of climate impacts is absolutely necessary for the benefit-cost calculus required for developing rational and appropriate policies to adapt to and mitigate the effects of climate change.

W4-H.5 McGill WL; wmcgill@ist.psu.edu

College of Information Sciences and Technology, The Pennsylvania State University

WHAT ARE SERIOUS GAMES AND WHAT CAN THEY DO FOR THE RISK COMMUNITY?

As argued in the mid 1970s by game pioneer Professor Dick Duke, gaming is the “future’s language.” What Professor Duke meant was that games, among all

other forms of communication, offer the greatest opportunity of communicate gestalt, whether it be to educate players on how a system works or to capture what a person thinks for the benefit of the game operator. In this talk we will explore the concept of a serious game and provide a overview of the current state of the art in developing and using serious games to accomplish some of the tasks that fall under the umbrella of risk analysis. We extend Professor Duke's thinking by exploring how serious games can be used to crowdsource analytic tasks for risk identification and evaluation, capture risk perceptions, measure uncertainty, educate players about risk concepts and provide a platform for risk communication. We consider both synchronous and asynchronous online and face to face games. Finally, we will consider the pitfalls associated with serious gaming for risk purposes (e.g., cheating, grieving, miscommunication, and player disinterest and impatience).

T4-B.5 McLain JL, Jordan W; mclain.jennifer@epa.gov

US Environmental Protection Agency

REGULATORY DECISIONS FOR NANOMATERIALS - EPA'S OFFICE OF PESTICIDE PROGRAMS

Under the federal law regulating pesticides, companies that want to sell pesticide products must apply for a registration and submit scientific and technical data for review by the Environmental Protection Agency (EPA) to ensure that the use of a pesticide will not cause unreasonable adverse effects on human health or the environment. Pesticide products containing nanomaterials, must meet the same safety standards as other pesticides. Scientific evidence shows that there are potential differences between nanoscale materials and their non-nanoscale counterparts. EPA must consider whether the small size of nanoscale materials or their unique properties may pose new or increased hazards to humans and the environment. EPA recently consulted with the Scientific Advisory Panel on how size and other properties of nanoscale materials potentially affect risk and how to assess such risks. Because pesticide products containing nanoscale materials may have special properties, EPA's data requirements will need to be tailored to the specific characteristics of the product under consideration. EPA's decisions regarding the data needed to support product registration will be discussed. EPA has received applications for pesticide products containing nanoscale materials and is aware of a registered product that was registered without the Agency's knowledge that it contained nanomaterial. EPA policies on how the Agency will make risk assessment and risk management decisions regarding these pending and previously registered products will be discussed.

T3-D.3 McLaughlin CF, Acuna Mohr B, Estrin AJ; cristina.mclaughlin@fda.hhs.gov

US Food and Drug Administration

INTEGRATING ECONOMIC THEORY AND GEOGRAPHIC INFORMATION SYSTEMS IN EXAMINING ENVIRONMENTAL, OCCUPATIONAL AND FOOD SAFETY CONSIDERATIONS FOR CULTIVATING FRESH PRODUCE ON THE VIRGINIA EASTERN SHORE

With increasing concern over food borne illness from fresh produce, there is a need to develop a holistic understanding of the current market and regulatory environment that farms must deal with in order to grow fresh produce, while reducing potential risks of product contamination and ultimately stay in business. A holistic view can illustrate the linkages and interactions between economic and geographic systems. An economic system includes the interactions of people, production and processes that are in place to meet a particular objective. A geographic system includes complex and interdependent spatial interactions. Within a systems framework, economic theory can point to the potential misalignment between the incentives of individual decision makers, such as producers or regulators and the interests of society overall. In this case the objective of fresh tomato farmers in the Virginia Eastern Shore is to produce tomatoes while minimizing their risk of pathogen contamination. The farmers act as agents in potentially conflicting spatial and non-spatial interactions between agricultural production of tomatoes and other economic activities in a geographic and economic system. This systems approach is facilitated thru the use of Geographic Information Systems (GIS) in order to help identify risk factors for different activities, both as a function of pathogen contamination or reduction, in the traditional epidemiological approach, and as a function of economic incentives or externalities.

P.43 McNeill D, Daron J; doug.mcneall@metoffice.gov.uk

Met Office Hadley Centre, London School of Economics

CHALLENGES IN RISK ANALYSIS OF THE IMPACTS OF CLIMATE CHANGE

We present a case study demonstrating the challenges in risk analysis for the impacts of climate change. Our example is health infrastructure in the UK, and potential methods for overcoming the challenges. Well-functioning hospitals are vital to the health of a nation. Climate change poses substantial risks to health infrastructure in the UK. Significant warming could lead to high summer temperatures in hospitals, compromising working conditions and endangering vulnerable patients. Hospital managers must balance the needs of patients (e.g. thermal comfort), clinical needs (e.g. cool operating theaters), cost, and energy consumption when planning hospital cooling options for the coming decades. They must take in uncertain information on climate risk from probabilistic climate predictions such as UKCP09, and set this

information in the context of regulation, and knowledge about their local environment. A further challenge is the nature of the climate predictions themselves. These are probabilistic, conditional on socio-economic scenarios and rapidly evolving scientific understanding, and often at too-large a spatial and temporal scale. We use a Bayesian network (BN) approach to study the risk of climate change to UK hospitals, and to help the decision making process. BNs are ideal for this purpose because they allow i) easy communication of the structure of a particular risk problem, ii) the combination of many uncertain parameters in a formal statistical model, and iii) the ability to model the consequences of decisions.

P35 McVey MM, Burch DF, Cleland JC, Dederick E; mmcvey@icfi.com
ICF International

TIERED, NATIONWIDE ECOLOGICAL RISK SCREENING FOR POTENTIAL INDIRECT EFFECTS OF LOCALIZED HCL AIR EMISSIONS IN EPA'S RISK TECHNOLOGY AND REVIEW (RTR) PROGRAM

ICF is assisting U.S. EPA's Risk and Technology Review (RTR) program in evaluating human health and ecological risks associated with exposures to air toxics, including point source emissions of chemical precursors to acid deposition (e.g., HCl). This case example demonstrates a three-tier screening process for evaluating potential risks to ecosystems from a chemical released from potentially hundreds of facilities nationwide. The initial tier uses readily available information on emission rates and likely vulnerable ecoregions of the country to rank facilities by potential susceptibility of the surrounding environment to the chemical. In this case, nationwide and regional maps of ongoing acid deposition rates and general soil alkalinity (to indicate acid buffering capacity) were used to obtain information on ecological vulnerability to HCl. The second tier uses GIS layers to further distinguish among the few dozen facilities of highest concern according to their proximity to ecologically sensitive or valued areas (e.g., national parks, other protected areas, surface waters). The final screening tier considers site-specific measurements of characteristics that are likely to influence susceptibility (e.g., soil and water pH) to rank the facilities of most concern. Numeric scoring of these parameters and a specified algorithm for their combination results in a hazard score for each facility. Additional site-specific evidence of past or ongoing ecological impacts is also sought and considered as available. The result of this analysis is the identification of a subset of facilities that are likely to represent the "worst case" ecological risk scenarios. If evaluation of those facilities in a refined ecological risk assessment indicates no appreciable risks, then the entire source category is assumed not to pose ecological risks for emissions of that chemical.

M2-E.3 Mechtenberg AR; amechten@umich.edu
University of Michigan

DESIGNING MULTIPLE BACK-UP ENERGY SYSTEMS FOR AN UNRELIABLE POWER GRID TO EVOLVE OVER TIME INTO A RELIABLE AND RENEWABLE MICROGRID

Due to extremely unreliable power grids in developing countries (especially Sub-Saharan Africa), all sectors are faced with the decision to choose a back-up energy system. The majority of the sectors choose diesel or petrol generators as a back-up energy system. Many in Africa choose solar panels, but the costs are prohibitive to supply all the needed capacity. After documenting many case studies of tragic as well as common consequences when both fail (even with regular maintenance schedules adhered to), this electricity model calculates the pathway to go first to increasing the number of back-up systems and over time to evolving into a complete microgrid. A case study at Virika hospital is presented. At Virika, there are seven back-up systems which increase the electrical reliability of the hospital for key power loads (e.g. lights during surgery). The evolution to a microgrid is done over time assuming capital and operating costs for recently purchased and/or utilized small scale back-up systems. Specific new locally built electrical designs are included to illustrate the ability to increase reliability for various health care activities at approximately 1/100th the cost of solar panels and 1/10th the cost of diesel and petrol generators.

W1-H.2 Mednick A, Parmar R, Wolfe K, Cyterski M, Wong J, Ziegler D, Zepp R, Zdanowicz R, Brody T; brody.tom@epa.gov
Wisconsin Department of Natural Resources, US Environmental Protection Agency, Ozaukee County Public Health Department

A COMMUNITY-FOCUSED RISK ANALYSIS TOOL FOR EVALUATING BEACH CONTAMINATION: VIRTUAL BEACH-MODEL BUILDER

The use of multiple linear regression (MLR) models for real-time beach water quality prediction is well-established and has been implemented successfully at several Lake Michigan beaches and elsewhere in the Great Lakes and coastal marine locations. Studies have shown that MLR models predict real-time concentrations of pathogen indicators, such as E. coli and enterococci, with greater accuracy than traditional, culture-based monitoring. Additionally, MLR models can assist beach managers with the process of identifying individual contamination sources and contributing factors. The widespread adoption of this method, however, has been limited in the past by the absence of a free, user-friendly tool for building, evaluating, and implementing such models. Faced with limited resources, local beach managers are unlikely to have the combination of staff time, modeling expertise, and/or commercial software necessary to successfully build and deploy MLR models for predicting beach water quality. To fill this void, the U.S. EPA has developed the Virtual Beach-Model Builder (VB-MB) software, which enables beach managers to build and refine

MLR models to predict pathogen indicator concentrations in real-time, based on meteorological, onshore, and near shore conditions. The Wisconsin DNR and the U.S. EPA have partnered to pilot-test VB-MB and conduct training for beach managers wishing to use the software. In this presentation we will introduce the VB-MB software and illustrate its key functionality through a local case-study. We will also discuss data collection (including Web-based data), model validation, and future directions.

W2-A.2 Meek ME; bmeek@uottawa.ca

University of Ottawa, Canada

INTERNATIONAL DEVELOPMENTS - MORE EFFICIENTLY ADDRESSING COMBINED EXPOSURES TO MULTIPLE CHEMICALS

Traditionally, consideration of effects of exposures to multiple chemicals has been based on the toxicity of similar combinations of chemicals or on the toxicity of components. However, the paucity of available data has limited the application of these approaches. As a basis to draw more efficiently on available information including predictive approaches, terminology and more efficient methodology for assessing the impact of combined exposures to multiple chemicals has recently been considered in a project of the World Health Organization (WHO) Programme on Chemical Safety (PCS). This project is being coordinated with additional initiatives of the International Life Sciences Institute (ILSI), the European Centre for Ecotoxicology and Toxicology of Chemicals (ECETOC) and the Organization for Economic Cooperation and Development (OECD). Following an international workshop to review advances in this area, a draft framework has been developed which includes problem formulation for assessment of combined exposures, followed by stepwise consideration of both exposure and hazard in several tiers of increasingly data-informed analyses. These analyses build on recent developments in assessment, incorporating predictive approaches in early tiers and increasingly refined, more data-informed mode of action and probabilistic analyses in later tiers. These developments draw from a range of programs internationally, including priority setting for Existing Chemicals under the Canadian Environmental Protection Act. Recommendations regarding terminology and the status of development of the framework, its content, review and application will be described and an example provided. Critical areas for future effort will also be described.

M4-G.3 Meek ME; bmeek@uottawa.ca

University of Ottawa, Canada

ENHANCING THE UPTAKE OF PBPK MODELS BY THE REGULATORY COMMUNITY. THE IPCS/WHO PROJECT ON GOOD PBPK MODELLING PRACTICE

Despite the availability of PBPK models for a number of chemicals incorporating significant additional biological data over default and the potential of these models to increase accuracy of risk estimates, their adoption in regulatory risk assess-

ment has been limited. This limited uptake has been addressed in a project undertaken as part of the World Health Organization/International Programme on Chemical Safety initiative on harmonization. The project engaged a planning group of risk assessors and model developers from North America and Europe and also drew on experience concerning approaches which have led to the comparatively greater regulatory acceptance of models of environmental transport and fate. The initiative included preparation of guidance and case studies on the characterization, documentation, evaluation and communication of PBPK models for risk assessment. Recommendations to facilitate uptake of these models in regulatory risk assessment include the need for early and continuing communication between risk assessors and modelers, greater consistency in consideration of weight of evidence of mode of action as a basis for selection of dose metrics in relevant PBPK models and sufficiently transparent documentation of model development to support potential application. More consistent and transparent consideration of the basis for and output of models relative to traditional default approaches in risk assessment is also addressed.

T3-G.3 Meek ME; Bette.Meek@uottawa.ca

University of Ottawa

ENSURING EFFICIENCY IN ASSESSMENT TO MEET IDENTIFIED NEEDS: THE IMPORTANCE OF PROBLEM FORMULATION/ISSUE IDENTIFICATION

The NAS report on "Science and Decisions" made recommendations to improve both the technical support for and the utility of risk assessment. One of the areas in which it made particularly valuable contribution was recognition of the importance of problem formulation/issue identification as a basis to tailor, from the outset, hazard characterization and risk assessment to provide meaningful information relevant to potential risk management options. The report also made mention of the need for, but did not develop approaches to "tiered" assessment strategies, as a basis to increase efficiency in assessment. The need for more predictive (mode of action) - based assessment methodology to enable more efficient assessment of much larger numbers of substances, consistent with the NAS report on "Toxicity Testing in the 21st Century" was also not emphasized in the Science and Decisions report. Approaches to dose-response characterization must be tailored to address the appropriate level of assessment (e.g., priority setting, screening or full) and relevant risk management needs and options. This presentation will address experience internationally in this context as a basis for broader consideration in the additional development of the Science and Decisions recommendations.

P.97 Meneses V, Alvarez P, Blazquez C; palvarez@unab.cl

Andres Bello University

A NEW METHODOLOGY FOR DETERMINING EFFICIENT ROUTES FOR PAVED STREET SWEEPING SYSTEM USING GIS AND GRAPH THEORY

Particulate matter in air pollution is a serious health problem of international concern. This pollutant is contained in the dust deposited on paved roads, which can be lifted into the atmosphere as the result of turbulence formed by the passage of vehicles through the paved road. This form of pollution is known as resuspended dust. Since 1996, a paved street sweeping and washing program has been implemented in the Metropolitan Region of Chile, using trucks to aspirate the dust deposited on paved roads with medium and high traffic flow, to prevent it from being resuspended to the air. In this study a new methodology is proposed, integrating Network Distribution theory and Geographic Information Systems in order to minimize both distance traveled by trucks, and operating costs of the street sweeping program, maximize the amount of particulate matter collected from the streets and improve air quality and life conditions of the inhabitants of Santiago. First, emission factors for the roads considered in the study were determined. Then a graph related to the distances between each side of the tracks that should be swept and washed was obtained through the development of a distance matrix using GIS technology. Subsequently, a greedy algorithm was implemented on the graph to determine the final route that trucks must follow to reduce the total traveled distance. Finally, we compared the results obtained using this methodology with the results calculated using the Classic Traveling Salesman Problem.

M4-E.3 Mensah Y, Pinto CA; ymens001@odu.edu

ODU

RISK OF DEPENDENCIES IN SYSTEMS DEVELOPMENT: THE GHANA SALT INDUSTRY STUDY

This presentation describes the challenges of managing the risks of interdependencies during the development of a system in a developing country, as well as the potential framework solution of using capability network analysis. A proof-of-concept application to the development of Ghana's salt industry is described. Salt is viewed as a key to Ghana's Industrial revolution because it can provide an opportunity to develop several raw materials available in Ghana for export and industrial use (e.g. petroleum), provide medical products needed in Ghana and neighboring countries, provide chemicals for clean water supply, and help develop new technologies for cluster industries. However, Salt and its cluster industries form a complex set of network systems whose development requires understanding of risk associated with their dependencies - also termed as enterprise and system-of-systems. The use of Functional Dependency Network Analysis (FDNA) for modeling risks resulting

from dependencies among elements of complex salt processing enterprise in Ghana is investigated. Two dimensions of dependencies are highlighted: strength and criticality. Also highlighted are the peculiarities of systems development and risk management in developing countries. This will be described using visual presentation for the complex system structure of the Ghana salt industry and the effects of dependencies between the related industries. Furthermore, the role of government in private sector development in Ghana's salt Industry is explored and key factors needed from government in support of private sector development is identified. Aside from contributing to the field of risk assessment and management, this study also contributes to the use of appropriate risk management tool in the context of developing countries.

M3-C.2 Merad M, Marcel F; myriam.merad@ineris.fr

INERIS

STRUCTURING CITIZEN PARTICIPATION IN TECHNOLOGICAL RISK MANAGEMENT PROCESS AND IN FRAMING CORPORATE SOCIETAL RESPONSIBILITY WITHIN THE FRENCH CONTEXT

Technological risks management is a public issue that raises different opinions, fears and apprehensions among societal stakeholders. At the same times, the challenges carried out by the implementation of the sustainable development principle within Public Organizations reveals difficulties in concealing with conflicting and incommensurable aspects such as environment, economic and social dimensions. Considering the French context, different events have contributed during the last years to deeply modify the public policy of both technological risk management and sustainable development. The first of those events is the Toulouse accident in 2001 that emphasizes the need to consider lay public and workers as active stakeholders in environmental decision-making in general and in industrial risk management. The second even is the organization in 2007 of a public debate on environment so-called "Grenelle of environment". These two events were materialized by the promulgation in France of the 699-2003 act on technological risks and the 967-2009 act of "Grenelle 1" respectively. Both acts suggest that the participative governance frameworks are needed for proportioned and responsible decision-making processes. Nevertheless, the exact role of those participative frameworks and the frame of stakeholders participation to the decision-making process remain fuzzy and dependant on the goodwill of the final decision-maker. Working groups and research project have been initiated since 2004 in order to provide a scientific and sound basis to participative governance in risk management and in the implementation of sustainable development principle within public organizations. In this paper, we proposed to discuss about: a methodology for structuring the participative processes and a discussion of its scientific foundations ; two applications of this methodology in the cases of the implementation of a risk management plan and to the implementation of a corporate social responsibility plan.

M3-H.3 Merad M; myriam.merad@ineris.fr
INERIS

ON THE USE OF PARTICIPATIVE RISK GOVERNANCE: QUESTIONING SCIENTIFIC EXPERTISE

In order to manage industrial and environmental problematic, policy-makers relies on scientific expertise to define public action policies to prevent risks to health and to environment. The relevance of this scientific expertise is more subject to controversy. At this two reasons. The first is due to variability, uncertainty and even permanent evolution of knowledge in the field of industrial risks. The second is due to changes in the political and social governance practices. This paper aims to provide a reflection on how to define the limits of scientific expertise and the way of questioning the devices of collective expertise. This will be addressed through 13 case-studies in the field of industrial risks and environment.

M3-D.2 Mettee SL, Neil KP, Herman KM, Griffin PM; kneil@cdc.gov
Centers for Disease Control and Prevention

SALMONELLA OUTBREAKS ASSOCIATED WITH LOW-MOISTURE FOODS IN THE UNITED STATES, 1950 — 2007

Salmonella is a major cause of foodborne illness and death in the United States, affecting persons in all age groups. PulseNet, the national molecular subtyping network for foodborne disease surveillance, has enhanced detection of Salmonella outbreaks associated with novel or “hidden” vehicles such as processed foods or dry ingredients. A multistate outbreak of Salmonella infections associated with peanut butter-containing products in 2008-2009 highlighted the potential risk of infection from contaminated low-moisture foods. Low-moisture foods are those with a water activity (aw) below 0.85, which inhibits the growth of most bacteria. We conducted a literature review and searched CDC’s National Outbreak Reporting System (NORS) to identify Salmonella outbreaks associated with low-moisture foods in the United States. We identified 34 low-moisture food outbreaks caused by more than 21 different Salmonella enterica serotypes from 1950 to 2007. Implicated items included beef jerky, chocolate, cereals, spices, nuts, and other foods. The number of reported Salmonella outbreaks linked to low-moisture foods during the most recent 10 years (1998-2007) was more than three times higher than in the previous decade. While it is unclear whether the increase in reported outbreaks is due to improved surveillance including PulseNet, increased food contamination, or other factors, it highlights the recognized risk associated with low-moisture foods.

T2-A.1 Miller WD; wilhelmine@gmail.com
George Washington University

HEALTH IMPACT ASSESSMENT: CONTEXTUALIZED INFORMATION FOR POLICY MAKERS

Health Impact Assessment (HIA) is a young field compared with its relatives such as environmental health risk assessment and economic projections that inform regulatory impact analyses. Its relative youth means that HIA practice has not been codified and particular HIAs encompass disparate methods and elements of analysis. Still, several key features distinguish HIA from related practices. These typical features include a wide-angle view of the potential health impacts of a policy, program or project with attention to their interdependencies and feedbacks; prominence of the distributive implications with a community or population as a whole; and community involvement throughout the process to identify problems and alternatives. Taken together, these characteristic features of the HIA tend to support a bottom-up approach to the analysis, and thus have the potential for providing policy makers with socially embedded and contextualized information about the likely impacts of potential policies or projects. They also constitute some of the less quantifiable and “messier” aspects of the HIA process. This presentation will consider how these important features of HIA can be supported and possibly strengthened and what they have to contribute to practices such as regulatory impact assessment.

P.11 Mitchell A, Casman E; austin.mitchell3@gmail.com
Carnegie Mellon University

ESTIMATING THE WATER RESOURCES IMPLICATIONS OF PRODUCING UNCONVENTIONAL GAS FROM PENNSYLVANIA’S MARCELLUS SHALE

Trillions of cubic feet of natural gas are locked below the surface in Pennsylvania’s Marcellus Shale, and new drilling and hydraulic fracturing technology coupled with proximity to important Northeastern US markets sparked a modern-day gold rush for the rights to Pennsylvania’s gas. Drilling and hydraulic fracturing a single well in the Marcellus Shale requires up to 10 million gallons of water from surface, groundwater or municipal supplies, and the expected number of wells to be drilled in this formation is in the thousands. In most instances, the gas industry plans to draw water from smaller streams and headwater creeks closest to their operations. This research characterizes the risks to the existing uses of Pennsylvania’s water resources posed by high-volume, transient water consumption by the gas exploration industry. Instream flow requirements maintain ecological integrity and protect downstream water users including municipal suppliers, industrial cooling systems and National Pollutant Discharge Elimination System (NPDES) permitted dischargers. Data on current water withdrawals and industry trends are used to predict the rate and location of future water withdrawals. The uncertainty in low (Q7-10) and mean stream

flow estimates for Pennsylvania's streams is characterized and compared with flow estimates used by gas producers to obtain water withdrawal permits to determine the probability of violation of flow-by requirements. Cumulative impacts of multiple withdrawals in the same watershed are assessed. The findings of this research are used to evaluate the adequacy of Pennsylvania's current permitting process with regards to water withdrawals.

W3-G.1 Mitchell-Blackwood J, Gurian P; jade@drexel.edu
Drexel University

BAYESIAN MODEL COMPARISON OF DOSE-RESPONSE MODELS FOR BIOLOGICAL AGENTS

A Bayesian hierarchical modeling (BHM) approach was used to evaluate observed dose-response data from three different pathogens: *Bacillus anthracis*, *Cryptosporidium* spp. and *Francisella tularensis*. This approach is fully probabilistic and allows for meta-analysis in which information is shared from related studies, for which parameters for unobserved conditions can be estimated. Other key advantages of BHM include: (1) the use of data sets, which might otherwise be uninformative; and (2) estimating inter-experiment uncertainty factors for extrapolation of results. This makes it well suited to the microbial risk assessment of the Category A and B pathogens since direct experimental data is scarce. BHM expresses the relatedness of susceptibilities and infectivities in the proposed studies in order to account for heterogeneity of both known and unknown sources. Because of its advantages, hierarchical models have been used in this way by many researchers and government agencies, often in parallel with classical statistical methods. However, the uses of these models require strong assumptions about the appropriate distributional form. Choice of one model's estimate over another can be based on qualitative measures of risk tolerance or by another means. In this analysis, we explore quantitative measures of model comparison, complexity and fit in order to provide a basis for parameter selection. Bayes' factors are the Bayesian alternative to classical hypothesis testing. Bayes' factors were used to compare (1) different hierarchical model structures and (2) three stage hierarchical models with two stage models that have individual fixed prior probabilities. The later was generated to simulate the classical maximum likelihood estimation. Results indicate that the hierarchical approach is strongly favored as inter-experiment variability increases. Deviance information criterion was then used to compare model complexity and fit of the hierarchical models.

T4-G.3 Mohapatra AK; asish_mohapatra@hc-sc.gc.ca
Health Canada (Alberta)

DATA FUSION APPLICATION TOWARDS A UNIFIED DOSE-RESPONSE ASSESMENT AND CONTAMINATED SITES HUMAN HEALTH RISK ANALYSIS

In NAS Silver Book (2008) "Toward a Unified Approach to Dose-Response (DR) Assessment", several short and long term recommendations were provided to address the need for a refined framework for DR assessments incorporating risk determinants (e.g., health status, vulnerability, & diseases, exposure) likely to interact with Mode of Action (MOA) of chemicals, affecting DR curves. NAS recommended data integration from environmental, public health and biomedical databases to develop markers and indicators of vulnerability to toxicant MOA. Further analysis of -omics data and chemicals with similar or multiple MOAs affecting same toxicologic process would improve understanding of the biological basis. NAS also recommended use of computing tools for these interactions. These recommendations were evaluated and applications of data fusion (DF) model were explored for next generation risk assessments. A modified version of the Joint Director's of Laboratories [JDL] DF model was evaluated to integrate data from different organizational levels (e.g., -omics, cellular, organism toxicity data, apical toxicity endpoints) that would help data analysts by refining data quality and to better understand uncertainties and variability. Further, DF model applications were explored to create a dynamic knowledgebase for better utilities in public health risk management decision making. Specifically, to address health risk issues with refined understanding of toxicant MOA data fused with molecular, biomedical, clinical, individual and population level exposure data can improve health risk analysis protocols. To validate these refined methodologies, contaminated sites chemical(s) examples could be used for further processing under this modified DF framework.

T3-D.2 Mojduszka E, Schaub J; emojduszka@oce.usda.gov
US Department of Agriculture

SUPPLY OF FOOD SAFETY IN MARKETS WITH IMPERFECT INFORMATION AND UNDER COMPETING INSPECTION SCHEMES (RISK MITIGATION STRATEGIES)

In 1996, the mandatory Hazard Analysis Critical Control Point (HACCP) system in the US meat and poultry industry was implemented and now plays an important role in the supply of higher quality, safer meat and poultry products. The HACCP system relies greatly on a sampling inspection policy specified by the 1996 Pathogen Reduction (PR)/HACCP regulation. Most recently, Food Safety and Inspection Service (FSIS) issued new standards for Salmonella Verification Sampling Program and related activities for poultry slaughter firms. The goal of these initiatives is to further increase the safety of poultry products and reduce the number of

foodborne illnesses. In this paper, we investigate the relationship between competing sampling inspection schemes (risk mitigation strategies) and the uncertainty associated with imperfect information about food product safety. We assume that the uncertainty related to sampling inspection creates moral hazard on food safety and changes suppliers' incentives to deliver safe products. We assume that requirements of sampling inspection regulations (e.g., sample size and acceptance level), fines and losses associated with failing inspection or contaminated product reaching the market and causing harm, affect market participant risks. More specifically, we develop a principle-agent model to evaluate how the parameters of various sampling inspection schemes influence suppliers' willingness to deliver safety when buyers and the regulator have imperfect information about suppliers' efforts. In contrast, to other (very limited) work in this area of research, our model concentrates on multiple market suppliers and buyers and the possibility of repeated food safety failures that can affect suppliers reputation in the long run. We then apply this unique modeling approach to the 1996 PR/HACCP as well as the more recent FSIS sampling standards.

T4-D.5 Mokhtari A, Beaulieu SM, Black P; amokhtari@rti.org
RTI International

DEVELOPMENT OF A FOOD SAFETY PRIORITIZATION MODULE FOR HAZARD-COMMODITY PAIRS

There is a need for using risk-based approaches that integrate sound science with state-of-the-art information technology to appropriately manage food safety risks. Two commonly used risk and decision analysis tools are risk ranking and risk prioritization. While the former typically focuses on the public health risks, the latter is multi-factorial in that it considers a whole cadre of factors (in addition to public health risk) that might influence the prioritization including, but not limited to, cost burden of the outbreaks, public perception, political will, impact on the industries, and trade impact. As a part of an integrated decision support system for food safety risks, we developed a web-based Pair Prioritization Module (PPriM) that provides a very flexible decision structure for use by risk managers in considering multiple attributes of a complex decision problem using an approach based on the Multi Attribute Utility Theory (MAUT). PPriM is "blind" to the attributes considered to ensure that the tool can be easily modified to accommodate changes in the decision process. This flexibility is critical to ensure that the module can evolve and adapt as we add new decision criteria and/or determine that some decision criteria are no longer relevant or useful. PPriM is connected to a comprehensive relational database that contains information on different decision attributes related to selected hazard-commodity pairs. PPriM supports a "swing weighting scheme" that allows the risk managers using any number of facilitation methods such as electronic survey, expert elicitation, multi-stakeholder discussions to determine the relative importance of each criterion to the decision. PPriM's output shows the user the resulting prioritization, along with

the concern scores, and credible ranges for the concern scores representing uncertainty for selected hazard-commodity pairs. High priority hazard-commodity pairs can be the target of risk intervention evaluation.

M2-B.2 Money ES, Reckhow KH; eric.money@duke.edu
Duke University

BAYESNETS FOR NANOMATERIAL RISK ASSESSMENT

Assessing the human and environmental risks of nanomaterials is a complex task given both the nature of the particles and the high degree of uncertainty that exists related to the exposure and hazard potential of these materials. General risk frameworks are built upon a combination of these two principles. For nanomaterials, these principles must integrate information related to particle characteristics (e.g., surface properties and aggregation state), environmental fate, and organismal/ecological responses. Given these complexities and the ongoing nature of multi-disciplinary research efforts, nanomaterial risk assessment may require new approaches to assess both the exposure and hazard in light of uncertainty. This presentation illustrates the use of Bayesian networks (BayesNets) to integrate a variety of knowledge bases related to the ecological implications of nanomaterials. From this perspective, we show a complex risk model based on probability assessment using a combination of physico-chemical models, experimental data, and expert judgment. The resulting model retains several properties that make it attractive for probabilistic risk assessment, including being decomposable, testable, integrated, and formally updateable as our scientific understanding of nanomaterials and their behavior in the environment progresses.

M2-D.3 Moolgavkar SH; moolgavkar@gmail.com
Exponent, Inc.

BBDR MODELS FOR THE ASSESSMENT OF RISK FROM EPIDEMIOLOGIC STUDIES

The process of cancer risk assessment involves much more than low-dose extrapolation. In particular, an understanding of how temporal factors, such as detailed exposure histories, affect cancer risk are essential to making rational risk assessment decisions. Yet, despite the fact that Haber's law rarely holds for human carcinogens, conventional statistical methods generally relate risk to cumulative exposure rather than the detailed pattern of exposure. BBDR models provide one way to incorporate detailed exposure histories in the analyses of epidemiologic data in cancer. The central problem in cancer epidemiology is to understand how the processes of mutation accumulation, and clonal expansion and selection, which characterize multistage carcinogenesis, are modified by genetic background and environmental factors. Although the paradigm is now firmly established, most epidemiologic studies of cancer incorporate ideas of multistage carcinogenesis neither in their design nor in their analyses. In this largely non-technical talk, I will give examples to show that using

ideas of multistage carcinogenesis can help reconcile seemingly contradictory findings, and yield insights into epidemiologic studies of cancer that would be difficult or impossible to get from conventional methods. I will focus on cohort studies of lung cancer. I will argue that the target of estimation in cohort studies should be not the relative risk, but the hazard function. The traditional statistical approach to the analyses of cohort studies is the Cox proportional hazards model. Proportionality of hazards is a strong assumption, however, which is often violated but rarely checked. BBDR models offer an alternative to the traditional approaches for analyses of epidemiologic data and offer important insights for cancer risk assessment.

W3-F.4 Morain MM; matt.morain@gmail.com

North Carolina State University

RAGIN' CONTAGION: VIRAL MEDIA AND THE SOCIAL AMPLIFICATION OF RISK

Social media tools and platforms have made it easy for web users to spread new ideas in established online communities. Ideas are rapidly disseminated to online communities, absorbed into the cultural digital consciousness of the moment, and reappropriated by new audiences for completely different purposes. Put another way, we could think of this challenging new communication context in terms of virality, or the understanding of how media spreads throughout the web by using models of contagion. Contagion has been linked to message proliferation in risk communication; virality studies offers an opportunity to understand the process. Understanding virality has become a holy grail for multiple online shareholders looking to capitalize on the changed media landscape, such as corporations trying to generate positive buzz about their brands while trying desperately to manage a nightmare of negative public perception that spreads and amplifies throughout online communities. But what makes content go viral? Is there a definitive algorithm for predicting virality? Despite the hype surrounding the social media conversation, the answers to both of these questions elude communication researchers at present; social media marketing "gurus" who have claimed to know the secrets of viral media are typically little more than snake oil salesmen looking to prey on public misunderstandings of new digital media environments. However, detailed case study analyses can provide an in-road into understanding what the field of risk communication can learn from-and offer-the new landscape of online viral culture. This paper presents case studies that demonstrate the principles and effects of digital media content going viral at three levels of impact: the endemic, repeatedly affecting a relatively small population of online users; the epidemic, quickly and significantly affecting a large number of users; and the pandemic, widely affecting a staggering majority of online media consumers.

W4-G.5 Moyer D; moyerdo1@msu.edu

Michigan State University Program in Public Health

CATEGORIZING THE TYPES OF RISKS TO PUBLIC HEALTH FROM COUNTERFEIT PHARMACEUTICALS

Counterfeiting pharmaceuticals is an economically motivated crime that introduces significant risks to public health. From patient deaths to populations at risk from drug resistant diseases, combating counterfeit pharmaceuticals is imperative. Understanding this heinous crime is difficult due to its complexity. A risk classification model is needed for proper assessment and mitigation. Many variables must be considered to categorize the risks associated with counterfeit drugs. The proposed Counterfeit Drug Risk Matrix first distinguishes among the various types of medical situations that precipitate the need for medications including: palliative medical conditions; diagnosed disease types such as non-life threatening, life-threatening, and terminal; and primary prevention within disease-free populations as well as lifestyle uses. These various medical situations reflect differing drug dispensing methods and supply chains. Each is further described as prescription versus non-prescription medication types. The matrix also considers the various types of counterfeiting such as dilution or substitution. Ingredient substitution is further segmented by the effect of the ingredient including benign, toxic, and lethal. All of this classification leads to defining the various risks at the patient level. The matrix then links these patient risks to the potential health risks at the population level. Lastly the matrix suggests the ability of detecting the counterfeit medication at the incident level. Clinicians can use the model in consideration why medicines don't perform as expected and to potentially explain unanticipated side effects at the patient level. At the population level, public health officials can use this model to prioritize anti-counterfeiting strategies and assess the effectiveness of anti-counterfeiting tactics. The primary benefit of the Counterfeit Drug Risk Matrix is to define the complexity of the public health risks due to counterfeit pharmaceuticals.

W2-G.3 Mukherjee D, Georgopoulos PG, Isukapalli SS; dp@ccl.rutgers.edu

Environmental and Occupational Health Sciences Institute, a Joint Institute of UMDNJ RWJ Medical School and Rutgers University

A WHOLE-BODY PHYSIOLOGICALLY-BASED PHARMACOKINETIC MODEL OF TOCOPHEROL FOR RATS TO SUPPORT ITS STUDIES AS A PROTECTIVE AGENT AGAINST NEUROTOXICANTS

Tocopherol (vitamin E) has been suggested as a potential neuroprotectant against Parkinson's and Alzheimer's diseases, mainly due to its anti-oxidative properties, and due relatively few side effects of tocopherol. Even though extensive animal studies and in vitro experiments have been reported for tocopherol kinetics, a whole-body physiologically based pharmacokinetic (PBPK) model for tocopherol does not currently exist in the literature. Here, a PBPK model for tocopherol for rats has been

developed that allows the estimation of concentration profiles in various organs and tissues following different tocopherol dose regimens. The PBPK model includes major organ systems that play a role in tocopherol dynamics, and explicitly models the brain compartment. It incorporates major reported biochemical mechanisms relevant to tocopherol transport and metabolism. It includes parallel transport by the vascular and lymphatic systems, and explicitly models the transport of tocopherol by different lipoproteins in the blood. The blood-brain transport is modeled using a Michaelis-Menten type formulation. Parameters for the PBPK model were primarily obtained from the literature and the model was independently evaluated with time-course concentration data reported in the literature. The model was able to adequately capture the concentration profiles in the blood and major tissues. The model was subsequently refined by using experimental data from the literature via Bayesian Markov Chain Monte Carlo analysis and global sensitivity analysis. The whole body PBPK model developed here can help in mechanistically relating tocopherol concentrations in the blood to those in the brain, which helps in informing the design of animal experiments for different dosage profiles. This information also helps in improving the interpretation of toxicological data from studies on neuroprotective properties of tocopherol, especially in relation to exposures to environmental toxicants.

W1-B.2 Naftz D, Fuller C, Krabbenhoft D, Perschon C, Luft J, Whitehead J, Gardberg J; dlnaftz@usgs.gov
USGS, UDNR, UDEQ

CHEMICAL AND PHYSICAL PROCESSES THAT INCREASE THE RISK OF MERCURY EXPOSURE TO BIOTA UTILIZING THE GREAT SALT LAKE ECOSYSTEM

The open water and adjacent wetlands of the Great Salt Lake (GSL) ecosystem support millions of migratory waterfowl and shorebirds from throughout the Western Hemisphere and a multi-million dollar brine shrimp industry. Recent biogeochemical assessments of the GSL ecosystem have found elevated levels of mercury (Hg) and methyl Hg in whole-water samples. Furthermore, the State of Utah recently issued health advisories for the unlimited consumption of three duck species harvested by hunters from GSL that consistently exceed the USEPA Hg screening level for human consumption. A number of chemical and physical processes that occur in GSL and the perimeter wetlands (described below) may be responsible for the increased risk of Hg accumulation in the biota that utilize this area. In the late 1950s, a rock-filled railroad causeway was completed, resulting in the formation of a higher salinity and anoxic layer in part of the lake, referred to as the deep brine layer (DBL). The large amount of organic matter and dissolved sulfate in the DBL stimulate sulfate-reducing bacteria, resulting in high concentrations of methyl Hg, which is highly toxic and biomagnified in the food web. Sediment focusing processes operating in GSL tend to deposit Hg in areas of the lake beneath the DBL where it is more

likely to form methyl Hg. Elevated concentrations of bromine and chlorine in the marine boundary layer overlying the lake-water surface may act as oxidizing agents that could enhance the formation of reactive gaseous Hg that could be deposited on the lake surface. Finally, enhanced nutrient loads from treated sewage effluent to the perimeter wetlands and increased primary productivity in the water column can result in less sunlight penetration and lower photodegradation rates of MeHg during daylight periods.

P.60 Nakayachi K; nakayachi@mail.doshisha.ac.jp
Doshisha University

A MEASURE TO REDUCE PUBLIC ANXIETY ABOUT HAZARDS

This study investigated the levels of public anxiety about a variety of hazards, and then examined the effects of measures to reduce them. Two thousand two hundred adults were selected from the basic registers of residents in Japan using a stratified two-step random sampling method. One thousand one hundred and ninety-two of them (54.2%) rated their anxiety toward fifty-one kinds of hazards. Six-point Likert scales were utilized for their ratings. A factor analysis extracted seven factors. A consequent analysis of variance revealed that people were most concerned about hazards that were loaded highly on a “global crises of environment” factor, followed by “major cause of death” hazards. The anxiety about well-known and historical disasters and accidents was rated low. Another two hundred and one adults randomly selected from the same registers rated their anxiety about hazards after they guessed the number of deaths by each hazard. The results revealed that participants’ anxiety about thirty-eight of the fifty-one kinds of hazards reduced significantly when they guessed the number of deaths caused by each. Participants increased their ratings after guessing the number of deaths only for cancer and brain and heart diseases, which cause two thirds of the deaths in Japan. These results indicate that estimating the number of deaths induces people to feel anxiety about hazards that is in accordance with the actual risk level. Implications and limitations of the present results were discussed.

W2-E.2 Nataghi R, Guikema SD, Quiring SM; sguikema@jhu.edu
Johns Hopkins University

STATISTICAL MODELLING OF POWER OUTAGE DURATION TIMES IN THE EVENT OF HURRICANE LANDFALLS IN THE U.S.

This talk will compare statistical methods for modelling power outage durations during hurricanes and examine the predictive accuracy of these methods. Being able to make accurate predictions of power outage durations is valuable because the information can be used by utility companies to plan their restorations efforts more efficiently. This information can also help inform customers and public agencies of the expected outage times, enabling better collective response planning and coordination of restoration efforts for other critical infrastructures that depend on electricity.

We compare the out-of-sample predictive accuracy of five distinct statistical models for estimating power outage duration times in the event of a hurricane land-fall in the U.S. The methods compared include both regression models (accelerated failure time and Cox proportional hazard models) and data mining techniques (regression trees, Bayesian additive regression trees and multivariate additive regression splines). Our results indicate that Bayesian additive regression trees yield the best prediction accuracy.

T4-I.4 O'Brien JP; JPO@co.clark.nv.us

Emergency Management, Homeland Security for the County of Clark, Nevada

CAN WE TALK? THE LIMITS OF TXVXC

Communication interoperability derives from common terminology in the risk analysis methods for homeland security. Chronic application of non-standard methods confuses the developers, users, consumers, and academics that require consistent language parameters in discussions and decisions regarding homeland security risk identification, analysis, and management. The path forward must forge the standardized lexicon of the risk stakeholder groups who can operate from a common center of understanding by eschewing the Risk = Threat x Vulnerability x Consequence ($R = T \times V \times C$) and embracing the commonly understood Risk = Probability x Consequence ($R = P \times C$).

M3-C.4 Oiso S; ooiso@inss.co.jp

Institute of Nuclear Safety System, Inc

PUBLIC ACCEPTANCE OF NUCLEAR POWER PLANT SEISMIC SAFETY

This study examined public acceptance of nuclear power plant seismic safety, in light of the growing public interest and concern over seismic safety of nuclear power plants after the Kashiwazaki-Kariwa Nuclear Power Plant in Japan was struck by a powerful earthquake in 2007. The study was conducted from January to February 2009 through a questionnaire survey in Japan (number of samples: 1,200; two-stage stratified random sampling). According to the survey results, 37% of respondents said they were concerned about radioactive leakage, even though they had heard the explanation that the amount of radiation leaked from the Kashiwazaki-Kariwa Plant was approximately one billionth of the annual dose of natural radiation received by the average person. This survey result indicates that electric power companies should take measure to communicate only a little radiation leakage information proficiently to receive people's acceptance. The percentage of respondents who feel that the Kashiwazaki-Kariwa Nuclear Power Plant being struck by an earthquake was an "accident" for which the Tokyo Electric Power Company (TEPCO) is responsible was higher in males than females, at 33% versus 23%. Considering that the percentage of respondents who said that 'nuclear power generation is necessary' was higher in males than females (76% versus 59%), it can be said that men have a severer attitude

toward the seismic safety of nuclear power plants than women do. The view that the Kashiwazaki-Kariwa Nuclear Power Plant being struck by an earthquake was an accident seems largely due to the fact that radioactivity was leaked, although in a very small amount. Eighty percent of respondents said they felt concerned upon hearing TEPCO's explanation that the scale of the earthquake was beyond the Company's expectations. It has been suggested that the public must be made to clearly understand that no matter how high the Company's expectations of the scale of an earthquake, an earthquake can occur that exceeds the level of expectations.

P.96

Oliveira MD, Bana e Costa CA, Figueiredo MS; monica.oliveira@ist.utl.pt
Centre for Management Studies of Instituto Superior Técnico, Technical University of Lisbon, Portugal

IMPROVING PROBABILITY IMPACT DIAGRAM MATRICES USING MULTIPLE CRITERIA DECISION ANALYSIS TOOLS

Risk matrices (i.e. tables mapping "frequency" and "severity" ratings to corresponding risk priority levels) have been recommended by international organizations and are widely used as a framework for practical risk analysis by many organizations and risk consultants. Nevertheless, available studies indicate that the use of risk matrices might generate inconsistencies in risk management and risk matrices do not respect important theoretical properties. This study investigates how multiple criteria decision analysis (MCDA) tools can be used to improve the design and the deployment of risk matrices in the context of prioritization of risks and of risk reductions. Using MCDA, it is proposed a modeling approach based on: (1) the use of a multicriteria additive value model using the Measuring Attractiveness by a Categorical Based Evaluation Technique (MACBETH) to measure risk impacts, and of the MACBETH methodology to build subjective probabilities; (2) the transformation of a risk matrix into a Probability Impact Graph (PIG) that uses probabilities and multicriteria value scores and that overcomes jump discontinuity problems; (3) the use of multicriteria and non-compensatory classification procedures to classify risks from the PIG by urgency of intervention; (4) and the use of multicriteria resource allocation models that combined with PIG can be used to identify which set of interventions are most effective to reduce risk, while taking into account of costs and other constraints. The proposed modeling approach is illustrated with data from a real case study developed at ALSTOM Power. The multicriteria additive value model was developed at ALSTOM following a socio-technical approach involving facilitation methods; and the application of the methods was supported by the M-MACBETH and PROBE decision support systems.

T4-I.5 Orozco GA; gorozcorestrepo@gmail.com

Universidad del Norte

RISK CULTURE: TOWARDS BUILDING A MODEL OF ANALYSIS AND INTERVENTION IN VULNERABLE COMMUNITIES

Risk as a category is a central and referent concept, which is immersed into the dynamics of the globalizations process. Even it has been positioned as an important axis of the processes that determines the social worldwide dynamics. In terms of the German sociologist Ulrich Beck, who has increasingly developed the world risk society category: the dynamic of risk society restless on the assumption that now and in future we must live in a world of unprecedented dangers; rather we live in a world that has to make decisions concerning its future under the conditions of manufactured, self-inflicted insecurity (Beck: 2008, World at Risk). Risk as a central category in social sciences includes two key operational concepts: multiplicity of threats, which are manifested in the economic, geopolitical, environmental, societal and technological (see Global Risk Report 2010) and the vulnerability that represents to the social units the exposure to potential hazards (natural disasters, nuclear proliferation, or terrorist attacks, forced displacement, among others). Therefore, risk is the combination of threats and vulnerability. In this context we will analyze the impact that the risk culture has, to develop the ability to face threats and reduce the propensity to vulnerability. We can define risk culture as an act in which citizens are mobilized to the politics common decisions to prevent-minimize effects of potential disasters and to strengthen democratic values around solidarity and access to information to face and manage global risk. Risk culture means the possibility of facing the multiple threats that modernity itself has constructed to confront and transform in enhancing their human security.

P.98 Osidele O, Mohanty S; oosidele@swri.org

Southwest Research Institute

A REAL-TIME DATA FUSION FRAMEWORK FOR ADAPTIVE ADVERSARY MODELING AND RISK ANALYSIS

The application of traditional probabilistic risk assessment methods to terrorism risk analysis is limited by the inability to handle adaptive decision making. Attack scenario analysis often represents adversary choices as random variables, and the resulting likelihood estimates are based on probability distributions of past events. However, historical data may be misleading indicators of future threats because an adaptive adversary can change the location or method of attack to exploit perceived defensive weaknesses. Innovative data management, active human involvement, and dynamic simulation and visualization capabilities are essential for enhancing defenses against adaptable threats. These attributes, if supported by real-time analysis and timely dissemination of intelligence information, creates a capacity for adaptive counterterrorism decision making. Because traditional risk analysis methods are in-

herently incapable of modeling the adversary's future attack choices, an alternative methodology is needed for trained personnel to actively operate a visual analytic data processing system and make real-time risk management decisions. This presentation describes a simulation-based framework for data fusion and threat analysis developed at Southwest Research Institute® for detecting potential attacks through real-time analysis of multisource intelligence data and critical infrastructure information. This innovative framework coordinates spatial, temporal, and semantic attributes of several intelligence and operational data streams using discrete event simulation to enable an analyst dynamically filter intelligence data and define threat alert criteria. Third-party software may be added to the framework to analyze simulation results, and estimate attack probabilities and potential consequences of detected threats. Proof-of-concept for this framework has been successfully demonstrated on nuclear material transportation and urban water infrastructure systems.

W4-D.3 Ott CM; c.m.ott@nasa.gov

NASA - Johnson Space Center

APPLICATION OF THE MRA GUIDELINE FOR HUMAN SPACE-FLIGHT

The risk of infectious disease during spaceflight has been difficult to estimate in part due to limitations in our knowledge of the effects of spaceflight on both the astronauts and microorganisms during the mission. As a result, health care efforts have historically relied on conservative, broad-based prevention and post-infection treatment. Over the past several years, the National Aeronautics and Space Administration has focused on developing quantitative microbial risk assessment evaluations to formalize the assessment process, define knowledge gaps, and quantify the risk of infectious disease. While many of the operational procedures and environmental conditions are unique to spacecraft, the basic approach follows the fundamentals described in the Microbiological Risk Assessment Guidelines, including hazard identification/characterization, dose-response assessment, exposure assessment, and risk characterization. For spaceflight, the ultimate goal of this work is the translation of these assessments into optimized microbial requirements that minimize unnecessary cargo and use of crew time, while still protecting the health of the crew.

W4-B.4 Palma-Oliveira JM, Carvalho RG, Carvalho J, Soeiro V, Luis S; palma@veritas.pt

University of Lisbon

IN CASE OF EMERGENCY, USE YOUR ATTITUDE: A COGNITIVE-ECOLOGICAL APPROACH TO NANOTECHNOLOGY RISK PERCEPTION

Every new technology is at some point in time socially scrutinized through the public's assessment of its potential risks and benefits, which is nowadays the case for nanotechnology. This has been widely studied in risk perception literature for many

types of risk. However, there are still some misconceptions regarding the factors that explain it. One of them is that information strongly contributes to risk perception. Given this, presenting people with different applications of nanotechnology should elicit equivalent risk perceptions, given that the level of information associated with each is equivalent. However, studies done by our own and other teams (Siegrist et al., 2007) show that attitudes play an important role and allow us to predict differences in evaluation, despite the knowledge level. For example, while evaluating the risk associated with the application of nanotechnology to food industry, people may associate this with their attitude toward the application of biotechnology to food industry. In one study, based on the psychometric paradigm, we found that while assessing risks, people perceived different applications as having different levels of risk perception. In another study, in which we provided people with information regarding the applications, prior to their assessment, it was shown that people's risk perception didn't change significantly when the information given was general. However, when we gave specific information about risks and benefits of each nanotechnology application, the perceived risk rate changed significantly. Another study used a comparison of technology and nanotechnology perceived risk in the same applied areas, thus assessing the role of attitudes in producing equivalent risk levels within the applied area. Accordingly, our goal is to support a cognitive-ecological approach which acknowledges that the cognitive processes that characterize human judgment and behavior are sensitive to the context in which they occur.

P.28 Pan SH, Lin MH, Ho WC, Chen PC; u9865006@cmu.edu.tw
China Medical University

HEALTH ASSESSMENT OF FINE PARTICULATE EXPOSURE IN TAIWAN

The impact of air pollution on health has been an important public health issue, for example: fine particulate (PM_{2.5}). World Health Organization (WHO) air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide (WHO/SDE/PHE/OEH/06.02) have been proposed to provide the protection of health hazards from exposure to air pollution. The objective of this study is to assess the health effects of PM_{2.5} and compare to WHO recommended criteria. There were two major databases in the analyses including 1) air pollution database from Taiwan Environmental Protection Agency and 2) mortality registry database from Ministry of Interior Department. In the all causes mortality analysis model, there was 1% increased mortality risk with increasing an inter-quartile range (IQR), 27.67 ug/m³, exposure in all season. There was higher risk in warm season, with 2% increased mortality risk. In the all cardiovascular diseases mortality model, there was 1% and 3% increased risk in all season and warm season respectively. There were 2%, 3% and 2% increased risk related to all respiratory diseases mortality in all season, warm season and cold season respectively but not statistically significant. Based on mortality

analyses of all causes, cardiovascular diseases and respiratory diseases, with increasing an IQR exposure could increase 1-3% mortality risk. The average (median) of PM_{2.5} concentration is 35 ug/m³ (30 ug/m³) in Taiwan during 2006-2008. WHO stage goal seems to provide a reasonable and suitable guideline. Further research and more international comparison are suggested.

P.13 Parker FL; frank.l.parker@vanderbilt.edu
Vanderbilt University

THE BLUE RIBBON COMMISSION CANNOT SOLVE THE RADIOACTIVE WASTE PROBLEM

Based upon the Charter, the Commission members, initial hearings- March 25-25 and May 25 and 26 and the organization of the Commission, the BRC will not "solve" the radioactive waste disposal "problem" because it is only nibbling on the edges of the "problem" rather than recommending fundamental changes in the approach as was suggested in the National Academy of Sciences' Rethinking High-Level Radioactive Waste Disposal", 1990. Though the approaches suggested then are still valid, they need to be updated to reflect what has occurred and what has been learned in the past 20 years and particularly the increased nuclear proliferation threat and terrorists' approaches that do not spare the lives of the terrorists. The new approach must be scientifically sound, technically feasible, economically reasonable, environmentally acceptable, societally benign and not be resource limited. The demand for a 1,000,000 warranty is technically impossible to prove, unrealistic based upon how fast our society is and will continue to change and promotes a fear of radiation effects that are not in keeping with reality. The recent National Council of Radiation Protection Report 160 shows that the average person in the United States is annually exposed to thousands of times greater dose from ionizing radiation from sources other than from nuclear energy and its wastes. Finally, to remedy these faults, one should further investigate the winning of uranium from ocean, now at a cost of only twice the spot price of uranium. This reserve of 4.5 billion tons would eliminate the need for reprocessing with its costs, and proliferation and accident risks. Direct disposal of spent fuel in the sub-seabed sediments would be virtually terrorist safe and have minimal accident consequences. With the increased use of nuclear energy, sea level rise would be decreased with the most benefit to island nations.

M2-I.1 Parnell GS, Merrick J; gregory.parnell@usma.edu
United States Military Academy, Virginia Commonwealth University

A COMPARATIVE ANALYSIS OF PRA AND INTELLIGENT ADVERSARY METHODS FOR COUNTER-TERRORISM RISK MANAGEMENT

In counter-terrorism risk management decisions, the analyst can choose to represent terrorist decisions as uncertainties or as decisions. We perform a comparative analysis of PRA, decision analysis, game theory, and combined methods on the same problem. A key tenant of PRA and decision analysis is the use of subjective probabil-

ity to assess the likelihood of possible outcomes. For each technique, we compare the assumptions, probability assessment requirements, risk levels, and potential insights for risk managers.

P.20 Parvez S, Teuschler LK, Narotsky MG, Simmons JE, Rice GE; parvez.shahid@epa.gov

NCEA US Environmental Protection Agency Cincinnati

EVALUATION OF THE USE OF BODY WEIGHT AS A COVARIATE IN THE ANALYSIS OF PUBERTAL ACQUISITION IN RATS

Many rodent bioassays of environmental toxicants examine the development of the reproductive system. A complex set of neuroendocrine functions mediate the onset of puberty, which is characterized as the day of preputial separation (PPS) and the day of vaginal opening (VO) in male and female rats, respectively. In rat bioassays, differences between treatment and control groups for PPS or VO are commonly interpreted as indicators of reproductive toxicity. With respect to body weight, the heavier rats are generally thought to acquire puberty earlier than lighter rats. In statistical analyses of PPS and VO onset, body weight measures both at weaning and at puberty have been used as covariates. Here, we sought to evaluate the relationships between pubertal and weaning body weights and the timing of the onset of puberty, and to evaluate the relative merits of using these body weight measures as covariates in the analysis of puberty onset. We obtained individual animal control data from 27 bioassays using Sprague-Dawley and Long Evans rats. Control data were chosen for these analyses because they are independent of treatment effects. Preliminary analysis suggests that in both male and female Sprague-Dawley rats, pubertal body weight, which is confounded with age, is strongly correlated to the day of puberty onset, whereas weaning body weight is inconsistently correlated. Continued efforts will compare results across sex, strain, and administration vehicles. [The views expressed in this abstract are those of the authors and do not necessarily reflect the views and policies of the U.S. EPA]

P.112 Patterson J, Willis A, Dourson M

Toxicology Excellence for Risk Assessment

AN INDEPENDENT EXPERT REVIEW PANEL OF A COMMUNITY-WIDE HUMAN HEALTH RISK ASSESSMENT FOR A NORTHERN CANADIAN SMELTER COMMUNITY

An independent expert review panel (IERP) met in June 2009 to conduct a peer review of a draft community-wide human health risk assessment (HHRA) for the community around a northern Canadian smelter. The draft HHRA was prepared by Intrinsic Environmental Sciences, Inc., to address the potential health risks associated with exposure to smelter-related metals in soils and other environmental media in the Flin Flon, Manitoba, and Creighton, Saskatchewan communities where the Hudson Bay Mining and Smelting Co., Ltd., (HBMS) has operated a mining and

smelting operation since the 1930s. In 2007 the Flin Flon Soils Study was initiated to provide better characterization of the HBMS facility emissions and soil conditions in order to determine if exposure to the metals and metalloids may pose an increased health risk to those in the area. The HHRA identified the chemicals of concern - arsenic, cadmium, copper, lead, mercury and selenium. The HHRA used measured concentrations in the local environment, along with exposure assumptions, to predict exposure for the residents. The peer review was organized by Toxicology Excellence for Risk Assessment (TERA) and utilized a process that emphasizes independence, transparency, and scientific robustness. The purpose of this peer review was to convene a panel of scientists with appropriate expertise to evaluate and judge the scientific basis and appropriateness of the subject documentation and its conclusions, as well as provide recommendations for improvement. The expert panel reviewed the HHRA and supporting documentation prior to the meeting and then systematically discussed the data, assumptions, methods, and results of the problem formulation, exposure assessment, hazard assessment, risk characterization and uncertainties evaluation. The panel utilized a detailed charge to peer reviewers to insure a thorough and objective evaluation. The HHRA authors revised the HHRA to respond to the IERP comments and recommendations, which were subsequently reviewed to insure the authors' responsiveness to the panel's recommendations (reports available at <http://www.tera.org/peer/FlinFlon/index.html>). A Technical Advisory Committee with representatives from national and provincial agencies provided technical guidance and oversight for the HHRA and IERP; HBMS provided funding.

M3-A.4 Paustenbach DJ; dpaustenbach@chemrisk.com

ChemRisk LLC

REFLECTIONS ON THE ROLE OF RISK ASSESSMENT AT OSHA OVER THE 40 YEAR JOURNEY: HAS IT BEEN A BIG DISAPPOINTMENT?

Low-dose models for cancer were popularized in the mid-1970s and the field of chemical risk assessment was formalized as a federally endorsed approach in the early 1980s. At the time, there were hopes and expectations that these two skill sets would be brought into the daily practice and regulatory environment within OSHA; that didn't occur. Some insisted that all the occupational carcinogens should initially be regulated to a model estimated risk of 1 in 1,000 while others believed that that was not appropriate due to the clear differences between genotoxic and non-genotoxic carcinogens. Debates also routinely occurred between the modelers/theoreticians and the "old school" toxicologists who believed that a clear "threshold" existed for every chemical. Shortly thereafter, the physiologically-based pharmacokinetic modelers argued that animal data were nearly useless unless converted to the biologically-effective dose in humans. Without a clear understanding of the legitimate scientific differences among scientists, it is difficult to pass judgment on their success. This

paper will quickly review the history but focus on five suggestions for how OSHA can move forward expeditiously in revamping the occupational health landscape; all for the betterment of the worker and, ultimately, consumers of commercial products.

T3-H.3 Pavlova Y, Reniers G; genserik.reniers@ua.ac.be

Antwerp University

THE ROLE OF CLUSTER SAFETY GOVERNANCE (CSG) FOR PREVENTING CROSS-PLANT ACCIDENTS: DEVELOPING A GAME THEORY BASED DECISION AID

Every company situated within a chemical cluster faces domino effect risks, whose magnitude depends on every company's own risk-management strategies and on those of all others. Given that chemical companies are interlinked by domino effect accident links, there is some likelihood that even if certain companies fully invest in domino effects prevention measures, they can nevertheless experience an external domino effect caused by an accident if it occurred in another chemical enterprise of the cluster. Despite benefits of full cooperation among cluster members, companies are not inclined to cooperate on all levels due to various reasons. In this article a game-theoretic approach to interpret and model behavior of chemical plants within chemical clusters while negotiating and deciding on domino effects prevention investments is employed. We are looking for a sub-cluster of a chemical cluster with the property that if all chemical plants belonging to that sub-cluster decide to invest in cross-plant prevention, then for all companies belonging to the entire cluster the best strategy is also to invest in such prevention. We consider a stage game described in Reniers et al. (2009). The considered model of the conflict between safety and social cooperation belongs to the stag hunt class of games. Our paper suggests a method to construct valuation functions for a group of companies belonging to the larger cluster, based on available information about the most important characteristics of individual chemical plants belonging to a sub-cluster, and describes a process of searching for sub-clusters as a threshold of participation in the game.

W3-H.1 Payno Morant M, Prpich G, Peeler E, Thrush M, Rocks SA, Pollard SJT; s.rocks@cranfield.ac.uk

Cranfield University, UK, Centre for Environment, Fisheries and Aquaculture Science, UK

ASSESSMENT OF CONSEQUENCES OF EXOTIC FISH DISEASE INCURSIONS IN ENGLAND AND WALES

Import Risk Analysis (IRA) assesses the likelihood and consequences of a disease incursion resulting from international trade. The World Organization for Animal Health sets out, in the Aquatic Animal Health code, the four steps to conduct aquatic IRA, of which consequence assessment is the least developed*. This work shows the development of a standardized methodology for ex-ante consequence assessment of aquatic disease incursions by adapting examples of best practices taken from various industries to create a robust methodology. Economic consequences of

a pathogen affecting finfish in England and Wales were assessed quantitatively using stochastic distributions to assess 9 consequence attributes which assess losses to the farmer, government and the wider economy. Environmental consequences at the level of a river catchment using were assessed semi-quantitatively using ranges scored from 1 to 4 and weights from 1 to 5 to assess five environmental attributes, related to impact on wild fish populations and knock on ecological effects. The economic and environmental impacts are scaled to reflect the likely size of the disease outbreak (number of farms and catchments affected). Data and expert judgment from the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) were used. Finally, the efficacy of the proposed methodology was demonstrated using a case study of *Gyrodactylus salaris* incursion for farmed trout and freshwater wild salmon. The evaluation of the consequence assessment methodology demonstrated that it was fit for purpose, and may in the future be adapted for assessment of shellfish or marine species as well as for use in other countries. The developed methodology may also be used to rank consequences of different diseases and therefore may be used as a decision making tool for informing resource allocation. *Peeler, E. J et al, 2007; Prev. Vet. Med. 81(1-3 S):3-20.

W1-E.2 Perez AL, McKinley MA, Donovan EP, Anderle de Saylor M, Thuett KA; aperez@chemrisk.com

ChemRisk

AN ANALYSIS OF GLOBAL REGULATORY INITIATIVES REGARDING PHARMACEUTICALS AND PERSONAL CARE PRODUCTS; THE POTENTIAL ROLE OF BIOASSAYS IN RISK ASSESSMENT

Due to the increasing use and often unregulated disposal of both pharmaceuticals and personal care products (PPCPs), the presence of these chemicals and their breakdown products in wastewater and in drinking water has captured the attention of regulatory agencies worldwide. Uncertainty surrounds the fate of PPCPs not targeted by conventional wastewater treatment systems and the human health risks posed by their presence in drinking water are relatively unknown. There are few reported human toxicity data for many of these compounds at low concentrations; furthermore, the effect of chemical mixtures is not well understood. The threat to aquatic vertebrates and invertebrates is often poorly characterized. Traditional animal toxicity testing can be cost-prohibitive and not applicable to certain situations. In the past decade, there have been initiatives in the E.U., Canada, Australia, and the United States related to the use of bioassays to monitor chronic toxicity of PPCPs in water systems. Here, we conduct a review of the regulatory and published scientific literature; over 200 articles were considered. This paper contrasts and compares these various initiatives and offers a reflection on the future of the regulatory efforts. In addition, we provide a thorough analysis of the available bioassays for potential use in wastewater, post-treated effluent, and drinking water. The possible benefits of

using bioassays to replace or supplement the measurement of individual chemicals is discussed. Further, we examine the potential for use of bioassays to estimate the aggregate risk associated with complex mixtures.

W2-G.2 Perona R, Lee R, Tauxe J, Black P, Fitzgerald M; rperona@neptuneinc.org
Neptune and Company

PROBABILISTIC MODELING OF HUMAN EXPOSURE AND DOSE IN PERFORMANCE ASSESSMENTS OF RADIOACTIVE WASTE DISPOSAL

The U.S. Department of Energy (DOE), the U.S. Nuclear Regulatory Commission (NRC), and the U.S. Environmental Protection Agency (EPA) require the completion of performance assessments (PAs) to inform approval decisions for radioactive waste disposal facilities in the United States. PA modeling focuses on estimating the future release of radioactive contamination from disposed wastes, followed by transport of contaminants in the physical environment and estimation of radiation dose to human receptors. Approval decisions are contingent in part on estimated internal doses to future receptors being below deterministic thresholds. Although probabilistic methods have been used in PAs to evaluate uncertainties in radionuclide release and transport over time, to date these methods have not been commonly applied to receptor exposure and dose models. Important aspects of such models include representation of population variability, and the uncertainty associated with hypothetical future exposures at or near a disposal facility. In particular, the long modeling period specified in PA regulation and guidance - in some cases surpassing 10,000 years - requires careful definition of exposure model assumptions and boundaries in order to distinguish between variability and uncertainty. The complex nature of large-scale PA models, employing linked algebraic and differential equations, makes spatio-temporal scaling and analysis more difficult. In order to refine the exposure/dose component of a PA, a two-dimensional probabilistic approach to differentiate variability and uncertainty is described. The challenges of employing probabilistic methods for modeling future exposures and associated radiation doses, and the implications of modeling dose vs. cancer risk, are explored.

M2-G.2 Perrin F, Sanaa M; f.perrin@actilait.com
French Food Safety Agency, Direction of Nutritional and Sanitary Risk Evaluation

QUANTITATIVE RISK ASSESSMENT OF SHIGA TOXINE PRODUCING ESCHERICHIA COLI IN SOFT CHEESE

Shiga toxin producing *Escherichia coli* (STEC) is a group of bacteria strains inducing significant human diseases, such as renal insufficiency or Haemolytic Uraemic Syndrome (HUS), which mainly affect young children. Although the associated mortality is relatively weak (lower than 5 %), the consequences are severe and stay for life in a third of the cases. In France, more and more data concerning the presence of STEC in dairy products with raw milk are collected and listed. Cheeses made from

raw milk from goat and soft cheese from cow raw milk were involved in HUS cases in France in 2004 and 2005. Thus, the presence of STEC in dairy products made from raw milk is an emergent concern. However, to our knowledge no quantitative appreciation of risk related to STEC in dairy products was carried out. The objective of this study is to develop a quantitative risk assessment model about STEC in French raw-milk soft cheese. The complete process of cheese making, from milk contamination during the milking to consumption, is modelled. This model is based on data published as on industrial data concerning the transformation of milk and the bacterial growth. Our model takes into account uncertainty and variability in input parameters using probability distributions. We obtain the distribution of cheeses contamination throughout the process and the potential exposure to STEC is determined. Consumption data and existing dose-response models are studied to estimate the associated risk. The simulated results obtained are compared to available data in order to validate the model. Finally a sensitivity analysis of the model was carried out to determine parameters that have the most relevant effect on cheese contamination and the best management options.

M3-A.2 Perry WG; Perry.Bill@dol.gov
US Department of Labor

THE BENZENE DECISION AND RISK ASSESSMENT AT OSHA

In order to set new or revised standards governing workplace exposures to hazardous chemical and physical agents, the Occupational Safety and Health Act (OSH Act) requires that OSHA ensure that no worker suffers material impairment of health to the extent that exposures can be feasibly controlled. In light of the Benzene and other court decisions, this means that standards must be set to either eliminate significant risks or reduce such risks to the extent feasible. Thus, the OSH Act contemplates that standards for chemical and physical agents are to be as stringent as necessary to reduce significant risks. At OSHA, the Benzene decision prompted the use of quantitative risk assessment as a tool for establishing significance of risk to justify the need for regulation, and this practice has continued. OSHA's experience since that time demonstrates that, for chemicals associated with serious chronic effects, it has not been possible to eliminate significant risks despite setting exposure limits at the lowest feasible levels. This illustrates the challenges that are faced by employers and workers to reduce occupational health risks to the low levels typically achieved by regulation of environmental exposures. In recent years, the analytical requirements necessary for successful regulation of chemicals have increased as the science base supporting risk assessment and feasibility analysis has grown in size and complexity. To effectively address occupational exposures to chemicals in the future in the face of increasing scientific complexity and analytical requirements, OSHA is seeking ways to streamline the underlying analyses supporting rules, and is also exploring a number of alternatives to single-substance rulemaking. This presentation

will provide an overview of the legal basis for conducting risk assessment at OSHA and describe the challenges facing the Agency as it addresses occupational exposures to chemicals in future regulatory efforts.

P.92 Peterson MK, Bailey LA, Dodge DG, Goodman JE, Valberg PA; mpeter-son@gradientcorp.com

Gradient

RISK ASSESSMENT OF MESOTHELIOMA AMONG ELECTRICIANS

Electricians may have been exposed to predominantly chrysotile asbestos fibers from some electrical products and to a variety of asbestos types if they worked proximate to other skilled craftsmen or disturbed asbestos-containing insulation or other asbestos-containing materials. We conducted a weight-of-evidence analysis and risk assessment to determine what levels and types of asbestos electricians could have been exposed to, and whether those exposures could have led to an increased risk of mesothelioma. Exposure, toxicological, and epidemiological studies were evaluated based on a variety of factors, including their rigor, power, corroboration, relevance, and coherence within and among studies. Toxicological studies support an inflammatory mode-of-action for amphibole-induced mesothelioma, but the evidence for chrysotile causing mesothelioma is lacking. Our analysis of task-specific exposure studies, as well as general occupational exposure studies, found that estimated integrated exposure to chrysotile asbestos fibers encapsulated in electrical components was very low, while electricians' secondary exposure to free amphibole asbestos fibers originating from the activities of other tradesmen was relatively high. In addition, some, but not all, epidemiological studies reported elevated mesothelioma risks among electricians. Lack of exposure measurements, lack of discrimination among fiber types, undocumented employment history, and small sample sizes meant many of these studies were not useful in determining whether asbestos was a causal factor, although several studies evaluated exposure in some fashion (including via lung biopsies and qualitative work history evaluations). Collectively, these studies support an increased risk of mesothelioma in electricians exposed to amphibole, but not chrysotile, asbestos.

M3-E.3 Phelka AD, Finley BL; aphelka@chemrisk.com

ChemRisk

POTENTIAL HEALTH HAZARDS ASSOCIATED WITH EXPOSURES TO ASBESTOS-CONTAINING DRYWALL ACCESSORY PRODUCTS: A STATE-OF-THE-SCIENCE ASSESSMENT

Until the late 1970s, refined chrysotile asbestos was an ingredient in a large number of industrial joint cement compounds and consumer spackling and patching compounds manufactured in the United States. While some drywall accessory products were asbestos-free by the mid-1970s, in 1977 the Consumer Product Safety Commission issued a ban of consumer patching compounds containing "respirable,

free-form asbestos" and asbestos was subsequently removed as an intentional ingredient from all U.S. manufactured joint compound products by 1978. Although hundreds of thousands of individuals may have experienced direct or indirect exposures to asbestos in drywall accessory products prior to the ban, there has been no systematic effort to summarize and interpret the information relevant to the potential health effects associated with handling of these materials. In this analysis, we evaluate 1) published and unpublished literature describing fiber type and fiber length data for historic joint compound products, 2) relevant animal toxicology data from inhalation exposure studies, 3) measurements of airborne asbestos collected during actual and simulated use of joint compound during home renovation and construction activities, and 4) epidemiology data available for career drywallers cohorts. As part of this review, we develop estimates of cumulative chrysotile exposure associated with different industrial and consumer use scenarios and compare these estimates to no-effect levels derived for this fiber type. Where appropriate, we describe information gaps and suggest possible areas of future research. We conclude that the current weight of evidence suggests that career drywallers, and consequently consumer home renovators and bystanders to drywalling activities, were not historically at risk for developing asbestos-related disease.

P.95 Philbrick M; mphilbrick@berkeley.edu

University of California, Berkeley

THE CURIOUSLY UNDERSTUDIED TOXICITY OF NANOWIRES: FRAMING AND PRELIMINARY RESULTS

While the general field of nanotoxicology has exploded in the last five years, nanowires constitute a curious exception to the general trend. This poster will present bibliometric analyses in support of this claim, to frame the preliminary results from a series of ongoing nanowire toxicity studies. To date, our research has focused on silver nanowires with various lengths and surface coatings, in preparation for future studies of ZnO and Si-based nanowires. Our tentative findings so far include: 1. The aggregation and precipitation behavior of Ag nanowires is strongly influenced by biologically relevant media. In particular, results indicate a significant degree of protein adsorption with structural ramifications, even with nanowires functionalized with either PVP or SiO₂. 2. At concentrations above 20 µg/ml, silver nanowires appear to interfere with the MTT assay. 3. Long Ag nanowires appear more cytotoxic to human cell lines than short ones. 4. Micrography clearly demonstrates the uptake of Ag nanowires into A549 cells. 5. In contrast to finding 3, the data so far suggests that short Ag nanowires demonstrate more toxicity to *Daphnia Magna* than long ones. 6. Ionic silver in the form of silver nitrate produced an LC50 an order of magnitude lower than short, functionalized Ag nanowires. The inconsistencies among the above tentative findings will inform future research efforts. Possibilities include: 1. Under what sets of conditions is aspect ratio a compelling variable with

respect to nanotoxicity? 2. To what degree will the results from Ag nanowires generalize for other substances, such as ZnO and SiO₂? 3. What are the likely ecological effects of functionalization of nanomaterials in the longer term? What probable environmental conditions might govern the bioavailability of e.g. Ag ions in the natural environment?

P.36 Philibert A, Desprez-Loustau ML, Makowski D; Aurore.Philibert@grignon.inra.fr

INRA, France

PREDICTING INVASION SUCCESS FROM SPECIES TRAITS USING MACHINE LEARNING TECHNIQUES

Biological invasions, resulting from deliberate and unintentional species transfers, are a major consequence of globalization and pose a significant threat to biodiversity. Since only a small fraction of introduced species become invasive, predicting which species might become invasive after introduction is highly desirable. Several forest pathogenic fungi, an important biological group, are listed among the worst invasive species and no studies have specifically been carried out to identify traits correlated to invasive success. Our objective was to predict invasive success of forest pathogenic fungi from species traits using two machine learning techniques, CART and Random Forest (RF), through a two-stage process. First, we challenged the hypothesis that some specific attributes can be used to predict invasive species, by comparing classification rules derived from CART and RF with random classification rules. Then we examined which traits were selected by CART and RF. These questions were addressed using a dataset including 47 invasive and non invasive species of pathogenic fungi introduced into Europe each characterized by 19 biological traits. The performance of CART and RF was assessed by cross validation from this dataset. Results showed that predictions of invasive success were more accurate with classification rules derived from CART and RF than with random classification rules. Useful species-level predictors for discriminating invasive from non-invasive species were traits related to long distance dispersal, sexual reproduction, spore shape and number of cells, optimal temperature for growth and parasitic specialisation. This study demonstrates that some species-level traits can be used to predict invasion success in pathogenic fungi. Our results suggest that Pest Risk Analysis schemes based on sequential questionnaires could be further improved by taking into account trait interactions or combinations. Our results also confirm the interest of machine learning methods for species classification in ecology.

M4-B.1 Philibert AP, Loyce CL, Makowski DM; Aurore.Philibert@grignon.inra.fr

INRA, France

HIERARCHICAL MODELS FOR ESTIMATING RISK OF NITROUS OXIDE EMISSION IN AGRICULTURAL SYSTEMS

Nitrous oxide is a greenhouse gas with a global warming potential approximately 296 times larger than that of CO₂. The main cause of nitrous oxide emissions are essentially the phenomena of nitrification and denitrification in cultivated soils, nitrogen fertilization, and manure application. Many experimental studies have been made to analyze the contribution of agriculture to the nitrous oxide emissions. Experimental data were published in scientific papers, but no quantitative synthesis of these data has been done yet. Meta-analysis aims at combining results from a collection of independent studies to estimate a quantity of interest and to analyze the variability of this quantity between studies. The objectives of our work were i) to carry out a meta-analysis to estimate nitrous oxide emissions in different agricultural systems and different continents, and ii) to study the interest of hierarchical statistical models for analyzing published agronomic data. The dataset included data about crop types, nitrogen fertilization, manure management, soil characteristics, climatic conditions, geographical location, and nitrous oxide emissions. It was analyzed using two types of hierarchical models; a frequentist model (mixed-effect model), and a Bayesian model. Both models included a random effect describing the between site-year variability of nitrous oxide emission and several explanatory variables describing soil, climate, and cropping system characteristics. The Bayesian model was able to take into account prior information about the effects of these variables and to describe the uncertainty about parameter values. Our results showed that both models could be used to estimate nitrous oxide emission of different crops and to describe the variability of these emissions. Our approach could help the United Nations Intergovernmental Panel on Climate Change (IPCC) to assess the risk of greenhouse gas emission in agricultural areas and to identify crop management techniques to reduce it.

M2-C.2 Pidgeon N, Spence A, Poortinga W, Venables D; pidgeonn@cardiff.ac.uk
Cardiff University

PUBLIC PERCEPTIONS OF CLIMATE CHANGE AND ENERGY FUTURES: A NATIONAL BRITISH SURVEY

Climate change is an increasingly salient and pressing issue worldwide. Governments are recognising this with the UK aiming to reduce greenhouse gas emissions by 80% by 2050 and the US also recently outlining plans for ambitious reductions by 2050. Radical changes in both technology and individual behaviour as a whole are required in order to meet these targets, in particular with respect to the types and form of energy we accept and use. We will present new data from a major nationally

representative household survey (n= 1,822) conducted in the UK in early 2010 examining public perceptions of climate change and key related energy issues. Current attitudes towards climate change and climate risks will be explored alongside, and in relation to, attitudes towards key potential energy developments in the UK designed to reduce carbon emissions, in particular nuclear power and various renewable electricity schemes including wind farms. The survey also develops a novel measure of beliefs about energy security. A fuller understanding of public perceptions of both climate change and energy futures will help to facilitate the identification and development of appropriate policy, public engagement and risk communication in this field. Results will be discussed in relation to historical data, key global and national events and recent policy developments.

P.37 Pintar KDM, Fazil A, Pollari FP, Waltner-Toews D, Charron D, McEwen S, C-EnterNet Team Members ; katarina.pintar@phac-aspc.gc.ca
Public Health Agency of Canada, University of Guelph, International Development and Research Council

INTEGRATED ENTERIC DISEASE SURVEILLANCE, QMRA AND ECOSYSTEM HEALTH: HOW DOES IT ALL FIT TOGETHER? A CANADIAN PERSPECTIVE

The Public Health Agency of Canada developed a national integrated enteric disease surveillance program in 2005 (C-EnterNet) that encompasses the ecosystem health approach to public health protection at the community level. The system advocates for the adoption of integrated enteric disease surveillance to inform decision-making at the local level, and the incorporation of important tools like quantitative microbial risk assessment within this framework. A mechanism that is based on an ecosystem approach to health would help to synthesize information from various sources to make integrated, evidence-based public health decisions that ultimately affect, and are affected by, the local ecosystem. By enhancing surveillance, incorporating existing and emerging epidemiologic tools to monitor disease and attribute sources at the watershed level, this is feasible within what is normally done by key stakeholders, and will save time and resources in future. The approach is particularly effective if it is rooted in continued communication and collaboration across traditionally disparate disciplines (public health and water treatment, for example). A community's health mirrors the health of our environment-this is the basis of the ecosystem approach to public health. An ecosystem approach recognizes the links between humans and their biophysical, social and economic environments (Lebel, 2003). The approach recognizes the complexity of the public health challenge, and provides an alternative for solution development. A case study of the approach and the experiences to-date in C-EnterNet's first sentinel site will be presented.

W3-H.3 Pintar KDM, Fazil A, Pollari F, Waltner-Toews D, Charron D, McEwen S, C-EnterNet Team Members; katarina.pintar@phac-aspc.gc.ca
Public Health Agency of Canada, University of Guelph, International Development and Research Council

USING QMRA TO INFORM SOURCE ATTRIBUTION AND PUBLIC HEALTH DECISION-MAKING IN CANADA: A FOCUS ON CRYPTOSPORIDIOSIS

A quantitative microbial risk assessment model was developed to simulate the role of recreational water contact and drinking water consumption in the transmission of cryptosporidiosis in an Ontario community. This approach was used to help determine why cryptosporidiosis incidence rates are almost double the national rates in certain Ontario communities. Surveillance data were used to develop the research objective, and QMRA was used to help determine relative risks for different exposure pathways (drinking water versus recreational water contact), to both inform and support public health decision-making. For the recreational water exposure, stochastic simulations were based on plausible modes of contamination of a pool (literature derived), river (site-specific), and recreational lakes (literature derived). For the drinking water exposure, stochastic simulations were based on site-specific and literature derived values of water treatment removal efficiencies for *Cryptosporidium* oocysts. Important data gaps were identified. The findings from this study illustrate the need for systematic and standardized research to quantify *Cryptosporidium* oocyst levels in Canadian public pools and recreational beaches. There is also a need to capture the swimming practices of the Canadian public, including most common forms and frequency measures. The study findings suggest that swimming in natural swim environments and in pools following a recent fecal contamination event pose significant public health risks. Conversely, the measured risk from consuming treated drinking water in this community is negligible due to advanced drinking water treatment, despite high levels and frequencies of *Cryptosporidium* in the source waters. When considering these risks relative to other modes of cryptosporidiosis transmission, they are significant. Finally, the utility of applying quantitative risk assessment, in coordination with enteric disease surveillance data, to inform public health practice is demonstrated in this example.

M4-I.2 Pita JA, Kiekintveld CD, Tambe M; jpita@usc.edu
University of Southern California

RESOURCE ALLOCATION DECISIONS AGAINST ADAPTIVE ADVERSARIES

Game theoretic methods for making resource allocation decisions in security domains have attracted growing attention, including deployed applications at both the Los Angeles International airport and the Federal Air Marshals Service. To that end we present a new model for resource allocation decisions that allows for a more

expressive set of defender activities and attacker capabilities. Previous approaches have made one of two critical assumptions: (i) the defender has no knowledge of adversarial capabilities; (ii) the defender has perfect knowledge of adversarial capabilities. The first assumption leads to a policy that tries to maximize entropy subject to maintaining a certain level of security on each target, while the second assumption leads to a game theoretic optimal solution given a finite set of specific attack capabilities and defender resource allocations. The problem with the first approach is that it neglects any intelligence a security agency may have about possible adversary threats. Although the second approach incorporates such knowledge into the model, a critical failing is that it must enumerate all the possible threats, an impossible task given the vast space of possible threats. We propose a model that allows for a diverse set of resource allocation strategies and works towards addressing the vast attack capabilities of an adaptive adversary. Specifically, we model the possibility that adversaries can circumvent specific security activities if they are aware of common security measures. While we do not model what specific mode of attack they will use, we do know that within the vast space of possible threats there exists at least one that can achieve this circumvention subject to some cost associated with the amount of security that must be avoided. By incorporating adversary circumvention capabilities, our game model places additional value on diverse security measures, while still factoring in specific intelligence information.

W3-I.4 Post K, Arvai J; postkri1@msu.edu
Michigan State University

SUPPORTING INTERNATIONAL DEVELOPMENT DECISIONS: INTEGRATING INSIGHTS FROM RISK COMMUNICATION AND DECISION AIDING FOR HOUSEHOLD WATER TREATMENT IN EAST AFRICA

Research and practice in international development focuses on reducing risks and improving the quality of life for people living in developing regions of the world. Much of this work encompasses the closely related goals of poverty reduction, safeguarding human health and natural resources, providing basic education, and encouraging social justice and equality. But in pursuit of these goals, development practitioners have had to confront a number of challenges. Some, which admittedly are not unique to international development contexts, involve helping local people to: (1) recognize and understand the risks they face; (2) identify and characterize situation-specific objectives intended to guide decisions; and (3) become meaningfully involved in the design, evaluation, and selection of a preferred risk management option. Other challenges, however, are rather unique to development-specific contexts and include a mistrust of outsiders, language and cultural barriers, and low literacy levels. In confronting these challenges, many development practitioners have simply exported expert-driven decision support processes that, in our experience,

have largely failed to accurately capture the full spectrum of objectives and concerns that are of important to local stakeholders. With this as backdrop, our presentation will report the results of research we conducted in East Africa. With support from the National Science Foundation (SES 0924210), we conducted a series of interactive and interdisciplinary workshops in southern (Milola) and northern (Naitolia) Tanzania in 2010. The purpose of these workshops was to help local villagers to identify and select effective and culturally appropriate water purification systems for use at the household level. To do so, we developed a decision support framework that merged concepts from structured decision making, risk communication, public health, water quality testing, and — as a necessity — popular television cooking shows.

T3-D.1 Powell M; mpowell@oce.usda.gov
US Department of Agriculture

CONSIDERING THE FOOD SAFETY IMPACT OF SAMPLING PLANS

Increasingly, food safety management programs look to statistical quality control methods to help design and evaluate control measures. However, a generic statistical quality control model assumes that acceptance sampling plans are used exclusively as a direct quality control measure by identifying acceptable and unacceptable product or lots. Consequently, a testing program has no impact on lots that do not undergo sampling. By extension, a generic model of the food safety impact of sampling plans implicitly assumes that the degree of control achieved is independent of the consequences of non-compliance with food safety criteria specified by private or regulatory standards. An evaluation of the Codex Alimentarius sampling plans for *Listeria monocytogenes* in ready-to-eat foods provides an empirical example. However, testing for compliance with food safety criteria is also commonly (perhaps most often) used as an indirect control measure, with varying degrees of effect. This indirect control stems from the deterrent effect of actions by regulatory authorities or wholesale/retail business operators taken in response to the discovery of non-compliance (with legal standards or contract specifications). These actions may include more frequent inspection and audits, official suspension of operations, the loss of a contract with a large buyer, or de-certification by a private standard-setting body. In addition, a firm's compliance history may impact its tort liability exposure and insurance rates. These exposures to potential increased costs create economic incentives for food producing firms to limit the probability and degree of non-compliance. In principle, these incentives may be sufficiently weak that a testing program has no deterrent effect on lots that do not undergo sampling. Such a finding, however, is situation-specific. It would not hold in general or be irreversible, as incentives can vary geographically, among firms, and over time.

W1-F.2 Pradhan AK, Ivanek R, Gröhn YT, Bukowski R, Wiedmann M; akp49@cornell.edu

Cornell University, Texas A&M University

PUBLIC HEALTH IMPACT OF LISTERIOSIS DUE TO LISTERIA MONOCYTOGENES CROSS-CONTAMINATION OF DELI MEATS AT RETAIL LEVEL

The objective of this study was to estimate the relative risk of listeriosis-associated deaths due to cross-contamination of deli ham and turkey by *Listeria monocytogenes* at retail. Based on reported data, deli meats coming to retail were contaminated at a frequency of 0.4%. Three contamination scenarios at retail were investigated: (i) the baseline scenario, where no additional cross-contamination occurred at retail, (ii) further 2.3% products were contaminated as a result of cross-contamination at retail due to redistribution of *L. monocytogenes* cells from contaminated food products, and (iii) further 2.3% products were contaminated as a result of cross-contamination from retail environment. Using our previously reported *L. monocytogenes* risk assessment in deli meats with product-specific growth kinetic parameters (i.e., lag phase and exponential growth rate), cross-contamination of deli ham and turkey from contaminated products and environment at retail, was estimated to increase the relative risk of listeriosis-associated deaths by 3.7- to 6.1-fold. Sensitivity and scenario analyses indicated that the frequency of cross-contamination at retail from any source (food products or environment) was the most important factor affecting the final estimates of the relative risk of listeriosis associated-deaths. Overall, our data indicate that retail-level cross-contamination of RTE deli meats by *L. monocytogenes* considerably increases the risk of human listeriosis cases and deaths and further development and implementation of effective control strategies to reduce cross-contamination frequency at retail level will thus be important.

W1-H.4 Prpich GP, Pollard SJT, Rocks S, Evans J, Black E, Dagonneau J; gprpich@cranfield.ac.uk

Cranfield University

INFORMING DECISION PROCESSES USING STRATEGIC ENVIRONMENTAL RISK ASSESSMENT

Strategic level assessment of risk is an invaluable tool for informing high level decision-making processes. In particular, strategic risk assessment (SRA) can provide a systematic approach for comparison of otherwise incommensurate risks, thus providing a defensible and transparent framework which may be used to prioritize risks and in turn inform strategic decisions¹. Developing a framework capable of capturing the disparate nature of different risks is challenging and nowhere is this more typified than in the comparison of environmental risks, which are intrinsically complex, comprised of environmental, social and economic characteristics². The overall aim of the SRA framework is to stimulate open debate about risk and to

provide a vehicle linking those who hold information within an organisation to those who make decisions within the organisation. The model achieves this through the use of narratives and risk characterisation analysis which is intended to provide a holistic view of risk that integrates environmental, social and economic perspectives of sustainability. Structurally, the model uses a narrative to provide context and to describe risk in line with organisational objectives. Characterisation data (qualitative/quantitative) supports the narrative and is presented visually to enhance presentation. Stakeholder engagement, technical literature, risk assessments and expert elicitations were used to develop and populate the model with evidence. This presentation will highlight the development of the SRA model and will touch upon key barriers to successful implementation within an organisation. The authors would like to acknowledge Cranfield University, DEFRA, EPSRC, ESRC and NERC for their support. References: 1Pollard et al., *Science of the Total Environment* 400:20-31; 2008 2Pollard et al., *Risk Analysis* 24:1551-1560; 2004

T2-B.4 Rachman NJ; nrachman@gmaonline.org

Grocery Manufacturers Association (GMA)

ASSURING THE SAFETY OF ENGINEERED NANOMATERIALS IN FOOD: MEETING THE SCIENTIFIC, REGULATORY AND RISK COMMUNICATION CHALLENGES

Engineered nanomaterials (ENM) intended for use in or in contact with food pose uniquely challenging issues in regulation, risk assessment and risk communication. An interpretive overview of the existing legislative/regulatory framework for food additives, GRAS substances, food contaminants and pesticides will be presented, illustrating how uncertainties about ENM hazard and exposure impact regulatory safety evaluation and/or risk assessment in premarket or postmarket situations. It will be shown that by considering the “context-specific” nature of nanoparticle properties, useful concepts for adjusting current thinking about data requirements and interpretation may emerge that could be feasible within the present legal/regulatory framework. Such adjustments would also promote the clarity of ENM risk communication, thereby strengthening consumer confidence in the safety of food during the coming years while research to address key scientific uncertainties is ongoing.

T3-B.4 Rachman NR; nrachman@gmaonline.org

GMA (Grocery Manufacturers Association)

CONSIDERING THE FUTURE: PANEL DISCUSSION FROM SESSIONS 1 AND 2

A facilitated, cross-disciplinary discussion including the speakers from both sessions of the symposium, Food Applications of Engineered Nanomaterials - Part 1: State of the Science on Oral Toxicity and Risk, and Part 2: Approaches to Uncertainty and Risk Characterization, will provide perspective on the identified regulatory, risk assessment and risk communication issues, and decision-analytic approaches to deal with current uncertainties.

T2-H.2 Rak A, Faramarzi A, Simmons M, Vogel CM; andrew.rak@noblis.org
Noblis

MILITARY ANTICIPATION OF SULFUR HEXAFLUORIDE (SF₆) REGULATIONS TO PROTECT CLIMATE: A CASE STUDY IN PROACTIVE REDUCTION

Sulfur hexafluoride (SF₆) is internationally controlled under the Kyoto Protocol as a chemical with an atmospheric lifetime of thousands of years and an extraordinarily high global warming potential. The US Department of Defense (DoD) uses SF₆ for several aspects of its national security mission as well as for applications that mirror the uses of SF₆ in the commercial sector. SF₆ exhibits several very important physical characteristics that make it ideal for applications as a gaseous dielectric; insulating critical electric applications where arc quenching is necessary. These qualities also make SF₆ irreplaceable in very specialized military applications. This presentation will review the actions initiated by the DoD's Emerging Contaminants Program to identify uses of SF₆ and develop risk-based mitigation or replacement strategies in advance of legal requirements. The DoD recognized the need to control SF₆ and other greenhouse gases (GHGs) that contribute to global climate change and related regional/global instability that could result from rapid global climate change. The military is directing research into alternatives for SF₆ in weapons systems and also in basic and applied applications because drop-in replacements are not available. The DoD must manage the risks posed by and the need for SF₆ because it is a material critical to national defense. A number of critical military uses of SF₆ have no known replacements. The military is taking proactive steps to identify its uses of SF₆ and develop risk-based strategies that include reduction of use, recapture, and substitution. This early response to SF₆ will enable the military to respond in a risk-based manner to address GHG emissions and meet national defense requirements. Proactive leadership by DoD will have public benefits because military technology can also reduce SF₆ emissions in civilian applications and can motivate suppliers who anticipate market shifts.

M4-D.5 Ravel A, Davidson VJ, Fazil A, Ruzante JM; aamir_fazil@phac-aspc.gc.ca
Public Health Agency of Canada, University of Guelph, University of Maryland

DIVERGENCE AMONG CANADIAN EXPERTS ON HUMAN ILLNESS FOOD ATTRIBUTION

Source attribution quantifies human illness associated with a specific source, helping prioritize strategies to prevent and control infectious diseases. Expert elicitation has been used previously for this purpose but not in Canada. A snowball approach was used to identify 152 food safety experts within Canada. Experts were asked to provide their best estimate and 90% confidence limits on the proportion of total cases that are foodborne for: *Campylobacter* spp., *Escherichia coli* O157:H7,

Listeria monocytogenes, *Salmonella enterica*, *Shigella* spp., *Vibrio* spp., *Yersinia enterocolitica*, *Cryptosporidium parvum*, and Norwalk-like virus. Factor analysis was used to determine whether the variability in best estimates was related to self-assessed level of pathogen expertise or other background information. Cluster analysis followed by beta function fitting was undertaken on best estimates from experts who self-evaluated their expertise as 3 or higher. In parallel, Monte Carlo resampling was run using triangular distributions based on each expert's best estimate and its limits. Sixty-six experts encompassing various academic backgrounds, fields of expertise and experience relevant to food safety provided usable data. Considerable variation between experts in their estimated foodborne attributable proportions was observed over all pathogens, without any relationship to the expert's background. The 90% confidence limits varied between experts and pathogens as well. Both cluster analysis and Monte Carlo resampling clearly indicated disagreement between experts for *Campylobacter*, *E. coli* O157:H7, *L. monocytogenes*, *Salmonella*, *Vibrio*, and *Y. enterocolitica*. Other published expert elicitations have reported important variation between experts and high uncertainty within experts, but not to the extent observed. In the absence of more reliable estimates, the observed divergence between experts must be explored and understood before one can judge which opinion is the best.

W2-E.1 Reed DA, Zabinsky Z, Boyle LN; reed@uw.edu
University of Washington

RULE-BASED METHODS FOR INFRASTRUCTURE RISK ANALYSIS

Rule-based methods are employed for determining optimal emergency management strategies for rapid and efficient response of civil infrastructure to natural disasters such as earthquakes and hurricanes. These rule-based methods are derived in the form of "If-Then" statements employed in the response phase of the post-disaster process. It is noted that many of these rules were developed as part of the preparedness phase of emergency management planning. An interacting particle algorithm is used to evaluate the optimum of the rule-based methods [e.g., Molvalioglu et al. (2009)]. The algorithm relies on social performance measures that are captured using survey data gathered on the interactions within and across the system. These measures are based on expert assessments from the perspective of the emergency respondents within utility companies and the transportation infrastructure as the starting point. Strategies for increased resiliency are the primary objective of the study. Hence, the performance of the networked civil infrastructure is assessed through individual and combined network resiliency metrics derived from the MCEER-based model of resilience [Bruneau et al. (2003)]. Civil infrastructure is modeled as an interdependent networked system of eleven subsystems as investigated previously by Reed et al. (2009). References: Bruneau, M., Chang, S., Eguchi, R., Lee, G., O'Rourke, T. D., Reinhorn, A. M., Shinozuka, M., Tierney, K., Wallace, W. A., and Von Winterfeldt, D. "A framework to quantitatively assess and enhance the seismic

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M4-F.4 Renn O; ortwin.renn@sowi.uni-stuttgart.de

Stuttgart University

SOCIOECONOMIC DIMENSIONS OF GEO-ENGINEERING AND CARBON SEQUESTRATION: REQUIREMENTS FOR RISK GOVERNANCE

In recent times, attempts to improve adaptation to climate change by means of large-scale CO₂ absorption, sequestration and storage options have been discussed in scientific and political communities. These options range from increasing the absorption capability of the oceans, over weather changing patterns by inserting chemicals into the atmosphere to separating and storing carbon from fossil power stations. All these options can only be effective in global terms when they are applied either in large quantities or extended over vast areas. So far the discussion has been focused on technical feasibility, effectiveness, efficiency and to a lesser degree environmental implications. However, projects of such size will trigger major social, cultural and psychological impacts that need to be anticipated and taken into account before making any far-reaching decisions. The model of risk governance provides a suitable framework to include such impacts in the assessment, evaluation and management of the anticipated benefits and risks of these projects. The paper will address the risk governance framework and explore the methodologies for including the socioeconomic dimensions in an integrated effort to balance the pros and cons of large-scale geo-engineering. Based on empirical studies on public perception and evaluation of carbon sequestration in Germany, the emphasis will be on public acceptability, environmental justice issues, and social costs.

T2-A.3 Richardson MJ; max.richardson@cdph.ca.gov

California Department of Public Health

HEALTH IMPACT ASSESSMENT AS A TOOL TO INFORM CLIMATE CHANGE POLICY: THE BROAD HEALTH IMPACTS OF CAP AND TRADE REGULATION IN CALIFORNIA

Regulations aimed at climate change mitigation are likely candidates for health risk assessment-many regulations have the potential to change air quality and environmental contaminants, impacting cancer risks, all cause mortality, hospitalization, and other well studied health impacts. Many climate change regulations, however, also drive social and economic changes that influence a wider range of health impacts that may be unevenly distributed across the population. These impacts would otherwise fall outside the scope of traditional HRA practices. The California Department

of Public Health used health impact assessment (HIA) to bridge this gap, employing quantitative and qualitative methods to assess the broad health impacts of cap and trade regulation in California. This talk will outline the stakeholder process used to identify the health pathways connecting cap and trade regulation to health determinants, largely focusing on socioeconomic impacts. A wide range of health determinants were identified, including changes in air quality, employment, household energy costs, and health impacts associated with carbon offset projects and the use of trading revenue. Quantitative and qualitative analyses were used to assess changes in these health determinants, and their ultimate impact on a variety of health outcomes. The HIA was intended to inform a regulatory framework for cap and trade and expand the discussion to broader program costs and benefits. The substantial challenges in performing the assessment will be discussed, as will lessons learned and the ability of HIA to shape economic policies.

T4-F.2 Rickard LN, Scherer CW; lnr3@cornell.edu

Cornell University

ATTRIBUTING RESPONSIBILITY FOR VISITOR SAFETY IN A NATIONAL PARK: AN EXPLORATORY STUDY

A leading cause of death for Americans, unintentional injuries constitute a significant public health concern in the United States. Attracting hundreds of millions of visitors each year, national parks represent one context in which such injuries are both recurrent, and often fatal. In these settings, characterized by unique constellations of environmental and infrastructural risks and varied recreational opportunities, who is perceived as responsible for ensuring that injuries do not occur? How might this attribution of responsibility, in turn, relate to visitors' support for risk-preventative management policy within national parks? To date, limited research has considered these questions; yet, increasing promotion of parks as resources for diverse audiences suggests a need to build public support for National Park Service (NPS) management strategies. Using survey data collected from visitors in one national park, the following exploratory study approaches these questions from a wide theoretical perspective, drawing on psychological, sociological, public policy, and communication-related approaches to attribution theory. Results indicate that most visitors perceived themselves as responsible for their own safety; however, contrary to prediction, this variable failed to predict policy support. Significant predictors included perceptions of risk, participation in high-risk activities, and visiting the park with family and friends. Future directions for research in this substantive and theoretical area are discussed.

W4-I.3 Robins NA, Hagan NA; Hagan.nicole@epa.gov
North Carolina State University, Oak Ridge Institute for Science and Education

MERCURY MINING AND USE IN COLONIAL ANDEAN SILVER PRODUCTION: EMISSIONS AND HEALTH IMPLICATIONS

Archival and published primary sources were used in combination with secondary sources to develop the first estimate of elemental mercury vapor emissions resulting from cinnabar refining operations in Huancavelica, Peru. Additionally, previous estimates of mercury emissions were revised for amalgamation-based silver production in Potosí; (present-day Bolivia), during the colonial period, which utilized the mercury mined in Huancavelica. Between 1564 and 1810, approximately 17,000 metric tons of mercury vapor were released into the atmosphere from smelting operations in Huancavelica, while approximately 39,000 metric tons were released as vapor during amalgamation-based silver refining operations in Potosí; between 1574 and 1810. Although knowledge concerning the health and neurological effects of mercury was limited at the time, the historical record is laden with descriptions consistent with mercury poisoning. These estimates and documentary descriptions serve as the basis of a semi-quantitative assessment of exposures (using AERMOD) and health risks to workers and the general population (using current inhalation reference values) and are subsequently placed in the larger context of the emergence of a global economy. Disclaimer: This is an abstract of a proposed presentation and does not necessarily represent EPA policy.

T2-I.3 Robinson LA, Hammitt JK; lisa.a.robinson@comcast.net
Independent Consultant, Harvard University

BEHAVIORAL ECONOMICS AND BENEFIT-COST ANALYSIS

Economics is fundamentally concerned with human behavior. Traditional neo-classical theory assumes that individuals act rationally and are primarily motivated by self-interest, making decisions that maximize their own welfare. These assumptions have been increasingly questioned by work in behavioral economics that explores the psychological aspects of decisionmaking. Much of this research focuses on market transactions and the implications for program design. We instead focus on the implications for analysis - for assessing the costs and benefits of risk management policies and programs. We begin by providing a brief overview of the key findings from behavioral research, then consider four areas. First, behavioral economics suggests that values are reference-dependent and that individuals at times make decisions that are inconsistent with their assessment of their own welfare. We discuss the implications of these issues for valuing environmental, health, and other benefits, including both the incorporation of additional context-dependent attributes into valuation studies and the potential for improving study design so as to reduce decisionmaking errors. Second, behavioral economics challenges the assumptions underlying the traditional use of exponential discounting; we consider the implications of quasi-hyperbolic

discounting for benefit-cost analysis. Third, behavioral economics suggests that preferences are not purely selfish, but reflect a variety of social concerns. We describe the implications of social preferences for the inclusion of altruistic values in benefit-cost analysis as well as for the traditional distinction between efficiency and equity. Finally, we describe how the results of behavioral economics research affect the rationale for conducting benefit-cost analysis and the interpretation of the results. Throughout, we provide practical advice that analysts can implement based on research now available, and develop recommendations for further research.

T4-A.2 Rocks SA, Alarcon S, Collinson S, Crossley R, Dorey RA, Friedrichs S, Park B, Sutcliffe H, Grayson D, Pollard SJT; s.rocks@cranfield.ac.uk
Cranfield University, UK, Nanotechnology Industries Association, Belgium; NanoKTN, UK, Insight Investment, UK, Responsible Nanoforum, UK

UNCERTAINTY IN EMERGING TECHNOLOGIES: INFLUENCING ASSESSMENT, REGULATION AND GOVERNANCE

Emerging technologies, such as nanotechnology, have increased the need for the clear communication and understanding of risks within an organisation and within a supply chain, as well as the need for uncertainties to be acknowledged within the associated risk assessment. This presentation considers the inclusion of uncertainty within the risk assessment of nanomaterials and the development of mature organisations using engineered nanomaterials. Organisations' responses to nanomaterials have already been highlighted by the Royal Society/Royal Academy of Engineering report (2004) which raised concern that industry was not engaged with issues resulting from nanotechnology*. As a result an industry/academia/investor partnership was formed to establish a code of conduct for the use of nanomaterials (the Responsible Nanocode**). This code has been applied to a group of small and medium enterprises, research laboratories and larger organisations within the UK to validate the approach. A scoring system was developed against the Nanocode to allow comparison between and across organisations in each sector. The data was collected from published literature (such as annual reports) as well as grey literature sources, and interviews with individuals across the organisations. The individual responses from the interviews were compared to literature to validate responses. The results highlighted uncertainties within the benchmarking process as well as in the use of nanomaterials within manufacturing processes. Separate consideration of uncertainty within the risk assessment decision making process for engineered nanomaterials is also reported. * available at <http://www.nanotec.org.uk/finalReport.htm> **available at <http://www.nanotechia.org/content/activities2/responsible-nano-code/> sponsored by the Nanotechnology Industries Association, The Royal Society, Insight Investment, and NanoKTN.

W2-E.3 Rokneddin K, Dueñas-Osorio L; kr6@rice.edu

Rice University

TOPOLOGICAL BOUNDS FOR RELIABILITY AND RISK ASSESSMENT OF LARGE LIFELINE SYSTEMS

Disruptions to the functionality of small to significant portions of lifeline system components often lead to widespread discontinued network performance. Disruptions include natural hazards such as strong ground motions or severe wind, as well as deliberate attacks. Systematic investigation of component unreliability and their impact on the reliability of large lifeline systems provides unique insights about their reduced performance. Systematic reliability studies explore the impact of removing all possible sets of lifeline system components on network's performance and are known to pose computational demands that grow exponentially with the size of the network. This research presents a topology-based reliability approach to measure reliability metrics for large power transmission networks in terms of simple yet meaningful network operational indices. This work shows how reliability bounds developed based on network topology provide rapid reliability estimates of complex lifeline networks without conducting full combinatorial reliability assessments. The proposed bounds are established by investigating the topological characteristics of transmission grids in the states of Texas and California, USA. The results demonstrate that computational demand for the reliability estimation of complex networks can significantly reduce, enabling probabilistic risk assessments for decision making while keeping track of uncertainty propagation and ensuring tight reliability and risk bounds.

T4-E.1 Rosenbaum AS, Langstaff JL, Graham S; ARosenbaum@icfi.com

ICF International, US Environmental Protection Agency

PERFORMANCE EVALUATION OF US EPA'S AIR POLLUTANTS EXPOSURE MODEL (APEX): COMPARISON OF APEX MODEL PREDICTIONS TO PERSONAL EXPOSURE MEASUREMENTS

US EPA's Air Pollutants Exposure (APEX) model has been used to support EPA's reviews of National Ambient Air Quality Standards (NAAQS) for ozone, nitrogen dioxide, and sulfur dioxide. APEX is a probabilistic model that simulates the movement of individuals through time and space to estimate exposure in indoor, outdoor, and in-vehicle microenvironments. Required inputs to APEX include spatially resolved time series of hourly outdoor air quality concentrations, distributions of mass balance parameters for estimating pollutant flows between microenvironments, spatial patterns of residential populations, human activity diaries, and home-to-work commuting patterns. This paper describes two sets of comparisons of APEX model predictions with personal exposure measurements. The first compares the predictions with personal ozone exposures to children in Southern California. The second compares model predictions with personal nitrogen dioxide exposures in Atlanta.

In the case of the ozone exposures APEX predicted the average personal exposure concentration reasonably well, but underestimated the variability. This underestimation was likely due to an underestimation of the variability of the outdoor ambient concentrations resulting from inadequate resolution of spatial patterns. In the case of the nitrogen dioxide exposures the APEX simulated daily mean exposures are similar to the measured personal exposures when considering the values and range of the median concentrations as well as the values and range of the bounding percentiles given by the 95% prediction intervals. Any opinions, findings, conclusions, or recommendations are those of the authors and do not necessarily reflect the views of ICF International or the US EPA. This work has been supported by EPA under Contract No. EP-D-06-115.

M3-H.1 Ross RG, Lathrop JF; bob.ross@dhs.gov

Department of Homeland Security

RETHINKING TOTAL RISK MANAGEMENT

In 1981, Kaplan and Garrick presented what has now become the canonical question set in Risk Assessment - "What can happen?", "How likely is it that it will happen?" and "If it does happen, what are the consequences?" In 1991, Yacov Haimes observed that Risk Management includes more than Risk Assessment and he offered a question set intended to capture what he called "Total Risk Management." As correct as Haimes was in his basic observation - that there is more to Risk Management than mere Risk Assessment - his questions failed to adequately capture the full range of issues inherent in Risk Management or the totality of information needed to address them. Building on the foundation laid by Kaplan, Garrick and Haimes, this paper presents a more completely realized view of "Total Risk Management" together with an expanded set of questions intended to support this more comprehensive approach. Our take-away point for risk analysts: the risk analysis community should be aware of the larger risk management processes that their analyses are intended to serve, how it works, and how they should aggressively interact with that management process to do all they can to see that their analyses are effectively employed. Our take-away points for risk managers are simpler - risk managers need to better understand the complete risk management process and more faithfully execute the process in its entirety. The approach and questions set forth here are sufficiently general that they can be applied, with no more than minor rewording, to most risk management situations.

W3-D.2 Roszell LE, Hought A, Beall P, Picut CA; laurie.roszell@us.army.mil

Army Institute for Public Health

HEALTH EFFECTS OF EMBEDDED FRAGMENTS OF TUNGSTEN AND TUNGSTEN ALLOYS

Alloys of tungsten such as Tungsten/Nickel/Cobalt (W/Ni/Co) and Tungsten/Nickel/Iron (W/Ni/Fe) were developed as potential replacements for De-

pleted Uranium and as anti-personnel weapons. Two components of tungsten alloys, nickel and cobalt, are known carcinogens, and there is evidence that another component, iron, may increase the development of cancer. A study by Kalinich et al. (2005) demonstrated that rats implanted with W/Ni/Co developed aggressive, metastatic tumors, while rats implanted with Ni alone developed tumors but not metastases. These data suggest that Tungsten (W) alloys may present a unique health hazard to wounded Soldiers. To better understand the effects of these alloys as well as tissue changes preceding or accompanying such events, we implanted Fisher-344 rats with pellets of W, W/Ni/Co or W/Ni/Fe. Effects were assessed 1, 3, 6, 12, and 22-months post-implantation. Our study confirmed the results of the Kalinich study; within 6 months Fisher 344 rats implanted with pellets of W/Ni/Co developed metastatic tumors originating at the site of implant. No rats implanted with W or W/Ni/Fe developed overt adverse effects as a result of the pellet implantation. These results demonstrate that the W/Ni/Co alloy is a potent carcinogen in this animal model. In order to better predict whether these and other W alloys are of concern to Soldiers, further research is needed to understand the mechanisms by which this alloy and other W alloys behave in models of fragment wounding such as the one employed in this study.

W2-I.4 Rouse JF; jrouse@arete.com
Arete Associates, Supporting The Joint Staff

INCORPORATING THE INTERNATIONAL RISK GOVERNANCE COUNCIL BEST PRACTICES INTO THE CHAIRMAN OF THE JOINT CHIEFS OF STAFF RISK ASSESSMENT SYSTEM

Beginning in 2001, the Chairman of the Joint Chiefs of Staff (CJCS) was required by law to submit his annual assessment of the nature and magnitude of the strategic and military risks associated with executing the missions called for in the National Military Strategy. At that time there was no methodology, established data sources, lexicon or systematic approach. Over time, a risk-assessment system was established and continuously improved. The Joint Staff significantly improved the Chairman's risk assessment system and its utility to senior leaders in 2006 when it incorporated the major tenets of the International Risk Governance Council's 2003 White Paper- Risk Governance-an Integrative Approach. This paper describes how the Chairman's risk assessment system has implemented the Council's risk governance model in support of National and Department of Defense strategic decision-making processes. Lessons learned from this development effort have broad applicability to other government agencies and efforts to deal with highly qualitative risks arising from a complex, uncertain strategic environment.

W3-A.1 Rowell A; arden.rowell@gmail.com
University of Illinois

GLOBAL CATASTROPHIC RISK AND REGULATORY DESIGN

This presentation addresses two distinct challenges that global catastrophic risks pose to regulatory design. The first challenge is that of identification: what should count as a global catastrophic risk? There do seem to be some risks-for example, climate change, nuclear war, mass pandemic, or extinction-sized meteor strike-that merit special regulatory response. But a regulatory system that treats every severe risk like a global catastrophe will run into trouble (and out of resources) very quickly. The trick, then, is in finding a strategy for separating out the catastrophic from the merely bad, and the global from the merely widespread. Once a global catastrophic risk is identified, creating an appropriate response is complicated by the second challenge to be discussed: that of coordination. Preparing and responding to global catastrophes requires significant coordination among political stakeholders, and this coordination may be required even where the impacts of the catastrophe and/or the precautions against the catastrophe are differentially spread across countries and across populations. This paper addresses several regulatory design strategies for addressing both of these challenges.

W3-G.2 Rush-Sirski A, Driedger SM; andrea_rush-sirski@umanitoba.ca
University of Manitoba

SPATIAL EPIDEMIOLOGY AS A TOOL TO BETTER UNDERSTAND INFLUENZA-LIKE ILLNESSES: LESSONS FOR PANDEMIC PREPAREDNESS

There is a global appreciation that the risk of a devastating pandemic influenza exists. This is fostered by the interconnectedness of the world and the relative speed and breadth at which illnesses can spread, representing the spatial and temporal patterns of the movement of disease. Understanding these patterns could inform the identification and assessment of the perceived risk. - The objective of this research is to examine the patterns that exist early in a typical influenza season, in Manitoba, Canada, to see if the remainder of the season can then be predicted. Administrative data is routinely collected and housed at the Manitoba Centre for Health Policy. Retrospective influenza case data (2004-2009) will be analyzed spatially and temporally. Models will be created to determine if early seasonal cases are predictive of the location and burden of illness for a given year. Variables to be analyzed include population data; location data to investigate proximity to medical services; and socio-economic data to characterize those most at risk. Analyzing spatial patterns is an important aspect for pandemic preparedness, offering a better understanding of the elements of space and time. Taking into account the dynamics of the person to person spread, early seasonal influenza cases should provide a forecast of the severity of outbreak of illness for a given season and identify the locations and populations

most at risk. The management of the risk can thus be more localized and specialized, maximizing the efficiency of health care providers, not only with regards to seasonal influenza, but also in the case of other pandemics.

W2-B.3 Ryti RT, Perona R, Bernhard T; rryti@neptuneinc.org

Neptune and Company, Inc., USAID

EVALUATING RELATIVE RISK IN ENVIRONMENTAL ASSESSMENTS

The United States Agency for International Development (USAID) requires that an Environmental Assessment (EA) be approved prior to execution of contracts that may have environmental impacts. This paper examines issues arising from an EA for a project to build housing to accommodate refugees. In this project, existing refugee camps were sited proximal to a former mining and smelting area, resulting in measurable heavy metals exposure in the refugee population. Soil concentrations of heavy metals are regionally elevated and the preferred relocation site also has potential for risk from exposure to metals in soil, air, and foods. Alternative actions in an EA are compared among each other based on their associated health effects, environmental impacts, social/cultural impacts, and cost/benefit analysis. The paper addresses the issue of relative risk in an EA, and considers different methods for evaluating the relative risk of potential exposures at the relocation site compared to measured exposures and potential risks at the refugee camp. Risk communication concerns associated with this project and recommendations for integrating regionally elevated concentrations of heavy metals in a site-specific EA are also discussed.

T2-C.3 Safi A, Smith Jr. W, Zhongwei L; asafi74@yahoo.com

University of Nevada Las Vegas

RURAL NEVADA: THE INFLUENCE OF VULNERABILITY ON RISK PERCEPTION WITHIN THE CONTEXT OF CLIMATE CHANGE

Only few studies investigated the impact of vulnerability on risk perception within the context of climate change. These studies used limited scope of vulnerability focusing only on the physical component, even though an increasing body of vulnerability literature defines vulnerability of human systems as a function of three main components: Physical vulnerability, sensitivity, and adaptive capacity. While physical vulnerability is decided by the probability and severity of certain impacts to take place, both sensitivity and adaptive capacity are decided by the socioeconomic conditions of threatened communities and individual. Sensitivity reflects the level at which a system can be hurt or benefited by certain risks, whereas adaptive capacity illustrates the capacity of a system to mitigate, survive, adjust, take advantage of, and adapt to environmental hazards (Fussler and Klein 2006). In this research we investigate the impact of drought as a major climate change impact on Nevada farmers and ranchers' risk perception at four different levels: Physical vulnerability measured through assessing the variant water stress levels among the different re-

gions in Nevada based on differences in water availability, water use and population density; sensitivity measured through assessing the level of individual ranchers and farmers' reliance on the agricultural activities as a source of income (internal and external income diversity); adaptive capacity measured through determining farmers and ranchers' social status and relative poverty; and finally vulnerability as a function of physical vulnerability, sensitivity and adaptive capacity measured through the composite Livelihood Vulnerability Index developed by Hahn, Riederer and Foster (2009). This research aims at enriching the literature on the determinants of climate change risk perception and providing valuable knowledge to policy makers and scientists for more effective communication with the public on climate change.

P.57 Safruk AM, Sigal EA, Jackson B, Pinsent C; asafruk@intrinsikscience.com

Intrinsik Environmental Sciences Inc., Canada, Goss Gilroy Inc., Canada

THE INTEGRATION OF A COMMUNITY-WIDE HUMAN HEALTH RISK ASSESSMENT AND EXPOSURE STUDY (BIOMONITORING) IN EVALUATING HUMAN HEALTH RISKS IN A NORTHERN CANADIAN SMELTER COMMUNITY

A mine and base metal smelting complex was established in Flin Flon, Manitoba, Canada in the 1930's, producing copper, cadmium, and zinc metals. Emissions from the smelter have resulted in elevated concentrations of a number of metals and metalloids in the surrounding environment. As part of the larger Flin Flon Soils Study, a human health risk assessment (HHRA) was conducted between July 2007 and May 2010 to assess exposure and risks associated with arsenic, cadmium, copper, lead, mercury, and selenium. Results from the HHRA indicated that arsenic, lead, and inorganic mercury were present at concentrations in the local environment that warranted further assessment of exposure and risk. Based on these results, an evaluation of exposures was undertaken for children (under 15) in Flin Flon, Manitoba and Creighton, Saskatchewan, examining urinary arsenic, blood lead, and, urinary inorganic mercury levels. The Exposure Study was conducted between April 2009 and April 2010 to help refine and validate the HHRA's exposure estimates and to examine how levels of exposure compare to levels in children living in other parts of Canada and the U.S.. Overall, 447 children participated in the study providing 202 blood samples and 379 urine samples. Blood samples were analysed for lead, while urine samples were analysed for inorganic mercury, inorganic arsenic and total arsenic. The Exposure Study was also intended to help identify what personal factors are associated with the level of measured internal exposure of children in Flin Flon area. Following completion of the HHRA and the Exposure Study, the results of these two studies, as well as some additional scientific information such as a Community Health Status Assessment, were integrated to provide overall conclusions regarding the results of the Flin Flon Soils Study.

T3-H.1 Sager SL, Pinnix A, Clarkson JR, Atkins M; shawn.sager@arcadis-us.com
ARCADIS US, Inc., CSX Transportation

RISK-BASED CLOSURE FOLLOWING A RELEASE OF CONOSOL 260

Once constituents are released into the environment, the evaluation and development of cleanup levels follows one of two paths. The first involves constituents with previously derived toxicity values, drinking water standards or other types of screening values. The second involves a known compound or mixture with only a limited amount of toxicity data available or the use of surrogates. The focus of this paper is on the strategy used to characterize a release of a known type of mineral oil and the development of remedial levels used to support a closure determination. In February 2009, a train derailment resulted in the release of Conosol 260 from a single tank car. The product is an aliphatic solvent used in many consumer products. As a mid-range petroleum distillate, it was initially treated by the regulatory agency as a petroleum hydrocarbon and generic remedial goals were identified. Chromatograms of Conosol 260 were compared to those of known hydrocarbon mixtures to identify the appropriate petroleum hydrocarbon surrogate. Through the course of our study, we refined the remedial goals by incorporating surrogate toxicity values of mixtures that more closely resembled the released compound. This paper will present the strategy used to negotiate with the state to take the site to closure.

M3-E.2 Sahmel J, Devlin K, Paustenbach DJ, Hollins D, Gaffney SH; jsahmel@chemrisk.com
ChemRisk, Inc.

THE ROLE OF EXPOSURE RECONSTRUCTION IN OCCUPATIONAL HUMAN HEALTH RISK ASSESSMENT: CURRENT METHODS AND A RECOMMENDED FRAMEWORK

Exposure reconstruction for substances of interest to human health is a process that has been used, with varying levels of sophistication, for several decades. The importance of robust and high-quality exposure reconstruction has been widely recognized. It has also been noted that misclassification of reconstructed exposures is relatively common and can result in potentially significant effects on the conclusions of a human health risk assessment or epidemiology study. In this analysis, a review of the key occupational exposure reconstruction approaches described in over 400 papers in the peer-reviewed literature will be presented. These approaches have been critically evaluated and classified according to quantitative, semi-quantitative, and qualitative approaches. The approach selected for a particular reconstruction effort should be incorporated into a systematic framework for conducting exposure reconstructions. Our analysis indicates that much can still be done to improve the overall quality and consistency of exposure reconstructions and that such a framework will help to standardize the process in the future. The seven recommended steps in the exposure reconstruction process include identifying the goals of the reconstruction,

organizing and ranking the available data, identifying key data gaps, selecting the best information sources and methodology for the reconstruction, incorporating probabilistic methods into the reconstruction, conducting an uncertainty analysis, and validating the results of the reconstruction. Influential emerging techniques, such as Bayesian data analysis and combination/comparative methods, will be highlighted. Important issues that will likely influence the conduct of exposure reconstruction into the future include improving statistical analysis methods, addressing the issue of chemical mixtures, evaluating aggregate exposures, and ensuring transparency with respect to variability and uncertainty in the reconstruction effort.

M2-E.2 Samaras C, Curtright AE, Willis H, Ortiz DS, Johnson DR, Litovitz A; csamaras@rand.org
RAND

MODELING GHG EMISSIONS UNCERTAINTY AND INFRASTRUCTURE DECISIONS IN UTILIZING BIOMASS-BASED ENERGY

The greenhouse gas (GHG) intensity of biomass-based energy is highly dependent on how the feedstock is produced, transported, and processed. However, decisions about public and private investment in infrastructure to enable a low-carbon energy system must be made despite this uncertainty. This presentation will describe uncertainties in GHG estimates for the cultivation, preparation, and delivery of regional bioenergy feedstocks, explore approaches to expressing these uncertainties, and present results of a case study examining the impacts of processing and logistics infrastructure decisions on GHG emissions. The results will illustrate tradeoffs between feedstock and infrastructure choices to minimize GHG emissions, with implications for the marginal value of additional information.

T2-G.4 Sasaki K, Imamura H, Nakayama A, Yoneda M, Morisawa S; sasaki@risk.env.kyoto-u.ac.jp
Kyoto University

A NOVEL FRAMEWORK FOR LEUKEMIA RISK ASSESSMENT USING HUMAN BONE MARROW CELLS

Basically human health risks of chemicals have been evaluated through animal testing. However, there are so many agents that it is not possible to conduct animal testing for each chemical. Therefore, we propose a novel framework for risk assessment using radiation equivalent coefficient (REC). The health risk assessment framework for radiation exposure has been well developed based on the Hiroshima and Nagasaki epidemiological study. Hence, if we can convert the chemical exposure to the radiation based on the cell-level in vitro experiments, we can obtain the reliable and unified health risk estimates with less animal testing. In this framework, the exposure concentrations of agents to the target cells are estimated by Physiologically Based Pharmacokinetics (PBPK) model. On the other hand, the dose-response curves for chemicals are obtained based on the results of the cell-level in vitro experiments.

The RECs are determined by comparing the dose-response curves with that for the radiation. The purpose of this study is to validate this framework by evaluating the risk of benzene induced leukemia using RECs. We performed chromosome aberrations tests using human bone marrow CD34+ cells exposed to X-ray, benzene and its metabolites, and obtained the RECs of 0.00618 Gy/microM for benzene, 0.091 Gy/microM for catechol and 0.195 Gy/microM for hydroquinone. Using calculated concentrations in bone marrow and obtained RECs, the risk of benzene induced leukemia was estimated to be 1.2×10^{-7} - 2.8×10^{-7} due to the lifespan exposure to 1 microgram/m³ of benzene, which is about twentieth to thirtieth lower than the unit risk reported by USEPA; 2.8×10^{-6} - 7.8×10^{-6} . These are better estimates than those in the previous studies based on the similar framework and experiments using human peripheral blood lymphocyte cells and CHO-K1 cells. In addition, now we are performing fluorescent in situ hybridization (FISH) tests for the purpose of setting the RECs based on the occurrence frequencies of chromosomal translocations, and the results will be reported in detail at the symposium.

W4-B.2 Satterfield T, Harthorn B, Pidgeon N; satterfd@interchange.ubc.ca
University of British Columbia

EXPLORING THE PRE-HISTORY OF RISK PERCEPTIONS: ON THE IMPLICATIONS OF UPSTREAM RISK PERCEPTION WORK FOR EXISTING EVIDENCE AND THEORY

While most social studies of risk can be traced to social movements (e.g., against nuclear power or genetic modification) or risk events (contamination outbreaks or oil spills), a new category of interest - nanotechnologies - has emerged a priori of controversy. This interest reflects both the desire of some to anticipate even offset controversy, and the intent of others to consider public concerns early and often in the development of these new technologies. Paradoxically, most survey research indicates low perceived risk and/or high-perceived benefit of nano-enabled products or applications as well as the broad class, nanotechnology. Nearly as many (an aggregated 44% across eligible surveys) remain, simply, uncertain and refuse to offer risk/benefit judgments of any kind. This paper examines these patterns using results from two new surveys of nanotechnology risk and benefit perceptions amongst residents of the US. We explain both the characteristics of support, uncertainty, and aversion toward specific nanotechnologies and the extent to which existing theories of risk anticipate perceptions. Specifically, theories of trust, stigma, environmental justice, intuitive toxicology and the psychometric qualities of nano-materials are examined to better understand their salience (or lack thereof) in the absence of controversy and the emergence of still yet labile and uncertain judgments. We close with consideration of that which past risk research has taught us, its applicability to the present period, and the meaning of perceptions when they have yet to become (and may never become) animated by protest, media amplification or contentious social contexts.

P.5 Scanlon KS, LaPuma PT; scanlon30@yahoo.com

The George Washington University School of Public Health and Health Services

COMPARATIVE LIFE CYCLE RISK ASSESSMENT OF MUNICIPAL SOLID WASTE END-OF-LIFE MANAGEMENT METHODS IN AN URBAN SETTING

This presentation will discuss the development of a life cycle risk assessment technique to resolve human health and environmental issues in an urban setting. The assessment technique will be demonstrated by comparing end-of-life management methods for municipal solid waste (MSW) generated by The George Washington University, a school whose main campus is located in Washington, DC. The analysis will compare the life cycle risks associated with two options for MSW management: landfilling (at a facility equipped with gas to energy capability) and incineration (at an energy resource recovery facility). This application was selected because the potential human health and environmental risks associated with these MSW management methods are well-studied and data qualifying and quantifying impacts and risks are available in published literature and from government sources and industry. The presentation will conclude with a discussion of the advantages in using a life cycle framework with risk assessment techniques to inform policy decisions that protect human health and the environment and promote environmental equity. This project is funded, in part, by The George Washington University Institute for Sustainability.

T2-H.3 Scanlon KA, McDonald S; scanlon30@yahoo.com

Concurrent Technologies Corporation

TRANSITIONING TO LEAD-FREE ELECTRICAL AND ELECTRONIC EQUIPMENT: UNINTENDED CONSEQUENCES AND POTENTIAL IMPACTS TO THE DEPARTMENT OF DEFENSE

Effective July 2006, the European Union directive referred to as the Restriction of Hazardous Substances, or RoHS, limited the use of six hazardous substances, including lead (Pb), in electrical and electronic equipment (EEE). The aim of the directive was to ensure continued protection of human health and the safe recovery and environmentally-sound disposal of wastes generated from used consumer electronic equipment. Despite exclusions for military equipment and exemptions for leaded solder in high-performance electrical systems, the Department of Defense (DoD) may be impacted by the transition to Pb-free EEE because the EEE used in the DoD are procured from the same suppliers who comply with the RoHS Directive. In order to continue to sell electronic products outside the U.S., EEE suppliers will continue to transition toward compliance with the Pb-free regulatory requirements. The replacement of Pb in EEE is not without technical challenges: there is no single drop-in replacement for Pb in EEE solder and component finishes and the use of Pb-free components does not have the benefit of several decades of supporting performance data. In addition, the high-reliability, high-performance electronic

equipment used in DoD applications differs from consumer electronic equipment in its use (i.e., extreme temperature, altitude, shock potential), product lifetimes (i.e., decades of field use), and maintenance and repair activities. By eliminating the dependable and durable leaded components from EEE used in DoD systems, the reliability and sustainability of DoD mission critical equipment may be jeopardized. Potential unintended consequences resulting from the transition to Pb-free EEE include risks to defense Readiness and Training, Operations and Maintenance, and Acquisition, Research, Development, Testing & Evaluation. This presentation provides an overview of the life cycle risk assessment approach employed to assess potential impacts to the DoD and the advantages of this approach to evaluate potential unintended consequences.

M2-G.1 Schaffner DW; schaffner@aesop.rutgers.edu

Rutgers University

PRELIMINARY RISK ASSESSMENT FOR SALMONELLA IN FORMULATED DRY FOODS

Recent U.S. Salmonella outbreaks and recalls, including the Peanut Butter Corporation of America outbreak, the Plainview non-fat dry milk recall, and the Basic Food Flavors hydrolyzed vegetable protein recall have highlighted the importance of controlling Salmonella in Formulated Dry Foods. This risk assessment was undertaken to assist food companies in managing the risks associated with formulated dry food products that do not support the growth of Salmonella. Specific model components include: serving size, weight of contaminated ingredient per serving, Salmonella cells per gram, the effect of negative test results on Salmonella prevalence, the effect of thermal processing on Salmonella in the dry state and the effect on storage time on Salmonella survival. A component of the model was also created to use the effect of environmental sampling test results to predict finished product risk. Estimated number of illnesses resulting from contaminated servings was calculated using the FAO/WHO beta-Poisson dose-response model for Salmonella. The risk model was developed using the Microsoft Excel add-in, @Risk (Palisade Corporation, Ithaca, NY). Results show that even when foods are contaminated with very low levels of Salmonella, when millions of servings are simulated, hundreds or thousands of illnesses are predicted to result. Product manufactured with significantly (~1 year) older ingredients represent a measureable lower risk due to Salmonella die-off during storage. When hundreds of negative test results are obtained, the predicted risk is lower. Finally, when low water-activity foods are processed, Salmonella survival may present a significant risk unless very high temperatures and long times are used.

M4-D.4 Scharff RL, Zan H; scharff.8@osu.edu

The Ohio State University

REGIONAL VARIATION IN THE VALUE OF STATISTICAL LIFE: IMPLICATIONS FOR COST OF FOODBORNE ILLNESS ESTIMATES

Estimates of the social cost of foodborne illness are highly sensitive to how measures of lost life and lost quality of life are derived. Often, these measures are based on hedonic studies that derive the value of statistical life (VSL). Viscusi and Aldy (2003) surveyed over sixty VSL studies from ten countries, finding, predictably, that studies from developed countries result in higher VSL values than studies focusing on developing countries. This is consistent with the premise that health is a normal good. Similarly, given that the richest state in the United States (Connecticut) has a per capita income that is almost twice as high as the poorest state (Mississippi), the value for foodborne illness risk reduction, as measured by VSL, would also be expected to differ across the states. In this study, we conduct a hedonic wage study to examine variation in the value of statistical life across regions of the United States. By combining multiple years of individual level data from the Current Population Survey (CPS) with occupational fatality data from the Census of Fatal Occupational Injuries (CFOI) and occupational injury data from the Survey of Occupational Injuries and Illnesses (SOII) we derive the price of exposure to fatality risks for American workers. Preliminary results suggest a relatively high VSL in New England and a low VSL in the Southeastern United States. For many foodborne pathogens, VSL plays a dominant role in cost estimation. This implies that the use of national estimates for the cost of foodborne illness to assess the effectiveness of state or regional interventions may lead to over- or under-estimates of benefits in policy analyses.

P.65 Scharcks T, Bostrom A, Reimann-Garretson L, Rix G; abostrom@u.washington.edu

University of Washington

SEISMIC RISK PERCEPTION, PLANNING, AND MANAGEMENT IN NORTH AMERICAN SEAPORTS

North American seaports are key economic drivers for coastal regions and a critical link in U.S. and Canadian global trade. As demonstrated by devastating seismic events at Port-au-Prince, Haiti, Concepcion, Chile, and Kobe, Japan, ports are vulnerable to earthquakes and tsunamis. Investments in seismic mitigation through engineered infrastructure improvements, emergency response planning, and risk-sharing measures force majeure agreements are potentially cost-effective. Yet investment in disaster mitigation competes with other opportunities. Following Hellman and Poister, and Gregory and colleagues, we conducted a novel survey of chief engineers in North American seaports to examine port decision making and assess seismic risk perception and management. Surveys were pre-coded into five seismic risk categories to achieve a comparative engineering-based measure of the seismic risk faced by each

port. Using Dillman's five-mailing and internet hybrid survey technique we obtained an overall response rate of 48.8 percent (n=61). Survey results portray present governance arrangements at North American ports as diverse. Further, performance objectives for ports appear unrelated to the degree of privatization (chi-sq test, $p=0.59$). The most commonly reported performance objective is optimizing local or national economic development prospects. North American ports have multiple stakeholders with sometimes competing interests; risk decision making is decentralized with many different entities exercising influence over operations, repairs, and even future construction. Finally, respondents' seismic risk perceptions generally follow the engineering seismic design categories for their ports, yet there is little evidence that ports facing high seismic risk prioritize safety enhancements in their budgets more than ports facing lower seismic risk. Almost a third of responding ports have only informal or no emergency response plans. Together the findings suggest a need for greater attention to risk assessment and management in ports.

P66 Scherer CW, Yuan C, Levitan L; cws4@cornell.edu
Cornell University

SEEKING RISK INFORMATION: USING THE RISP MODEL TO EXPLORE RISKS WITH INDETERMINATE BEHAVIORS

The risk information seeking and processing (RISP) model attempts to better understand what motivates individuals to attend to information about a particular risk. Recent work on the model has suggested that key components of the RISP model could serve as antecedents to protective behaviors. However, in the context of the present study, we examine a situation in which protective behaviors are indeterminate. This study expands the RISP model by comparing two types of risks, a high-profile economic risk and a low-profile environmental/health risk. Neither of these risks has defined preventive behaviors. While increased information is generally thought to guide preventative or protective behaviors, and thus reduce uncertainty about particular risks, in these situations information seeking could increase distress by increasing uncertainty. The study utilizes survey data from 464 agricultural producers facing an immediate economic risk and a continuing low-profile environmental/health risk. The modified RISP model examined how in combination, information sufficiency, channel beliefs, channel usage, and perceived hazard characteristics influences current and intended preventive behaviors, information seeking, and information processing. Structural equation modeling techniques were used to test the adequacy of the entire model, along with simultaneous estimation of all the structural coefficients, and the corresponding significance tests for all coefficients. The results provided mixed support for the RISP model in studying information seeking across both indeterminate risks. Based on the results, revisions to the original RISP model were proposed. The paper ends with a discussion on the practical implications of the research.

T3-C.3 Schlag AK; anne.schlag@kcl.ac.uk
King's College London

MENTAL MODELS OF AQUACULTURE: IMPLICATIONS FOR RISK COMMUNICATION

Fish consumption is estimated to increase. In the context of diminishing wild supplies more seafood will be the product of aquacultural activities (FAO, 2006). Although traditional fish farming has been practised for centuries, modern aquaculture with its diverse production methods and novel technologies may incur future public perception problems. This is problematic because of the well-established benefits of fish consumption for human health. This highlights the need for establishing effective risk communications with the public about aquaculture. Because of the limited social research on aquaculture to date, it is vital to explore perceptions so that risks can be effectively communicated. We investigated expert and lay risk perceptions using the mental model approach developed at the Carnegie Mellon University (Granger Morgan et al, 2002). This is the first time that this approach has been applied to aquaculture. 15 elite interviews with scientific experts were followed by 28 focus group discussions with lay people to explore how the risks and benefits of aquaculture are understood. By utilising the CMU approach and allowing respondents to structure and define their own responses, we show how people conceptualise and describe issues related to aquaculture. In this way, the empirical assessment of what lay people already know together with a scientific determination of what people actually need to know about aquaculture can offer important foundations for the design of relevant risk communications. Results show that lay perceptions of aquaculture frequently differ from the scientific assessments, and that consumers are often confused with regards to expert terminology and current consumption guidelines. Whilst lay participants are generally unfamiliar with aquaculture, there are no strong prejudices against farmed fish as consumers weigh up both benefits and risks, indicating that perceptions are often ambivalent. This unfamiliarity and ambivalence highlights the need for improved risk communications about fish consumption, farmed or otherwise.

M4-G.4 Schlosser PM; schlosser.paul@epa.gov
US Environmental Protection Agency

A STRATEGY FOR EFFICIENTLY EVALUATING (AND IMPROVING) THE APPLICABILITY AND QUALITY OF PBPCK MODELS

PBPCK models are generally considered superior for estimating internal dosimetry from chemical exposure, hence extrapolating risk between routes of exposure, from animals to humans, or among diverse human populations, vs. use of standard extrapolation methods and uncertainty factors based on minimal physiological and chemical-specific data. However, one may need to choose among multiple published models for a chemical and while peer-review publication assures a level of scientific quality, it guarantees neither that the model is appropriate for a specific assessment

nor the consistency of the publication with the corresponding computer code. A process for reviewing published PBPK models and validating their computer implementation is therefore necessary, but can be time-consuming. Reviewers of draft risk assessments may also suggest changes in a PBPK model which would require further time and resources. With limited personnel time and financial resources available to conduct an assessment, where the PBPK model is just one component, a clear set of standards for model adequacy and accuracy and efficient strategies for model evaluation and the implementation of any necessary or desirable model revisions, is therefore suggested. An example process is presented which involves collaboration between the agency conducting the assessment and supporting contractors and seeks to engage the original model authors. Several errors found during application of this process will be identified, with suggested ways to avoid them. Practical barriers to model application will also be discussed, such as when a model cannot be applied to bioassay dose regimens. This presentation should be helpful for both risk assessors and researchers who wish to produce models more likely to be usable “off-the-shelf” for assessment purposes. (Disclaimer: The views expressed in this abstract are those of the author and do not represent the policy of the U.S. Environmental Protection Agency.)

W4-G.3 Schnatter AR, Glass D, Rushton L, Tang G; a.r.schnatter@exxonmobil.com

ExxonMobil Biomedical Sciences, Inc., Monash University, Imperial College, University of Pittsburgh

POOLED ANALYSIS OF BENZENE PETROLEUM WORKERS

There are few quantitative studies on the effect of relatively low benzene concentrations on leukemia risk. Three such studies involved petroleum workers in Canada, Australia, and the UK. These studies have been updated and pooled to provide greater power and precision on potential risks for leukemia subtypes and related diagnoses. Methods for exposure estimating and disease ascertainment were compared and deemed to be similar enough for pooling. Before pooling, the studies were updated with cases that accrued since the the studies were published. Quantitative workplace exposure estimates were compared across studies to ensure that any differences in these estimates were justified. To improve disease subtype classification, pathology records were obtained from hospitals, doctor's offices and medical files. Two pathologists classified every case according to ICD/FAB as well as WHO classification schemes. Both exposure and disease classifications were graded by certainty, allowing sensitivity analyses that included only high quality information. Statistical analyses employed conditional logistic regression models with flexible penalized cubic regression spline components. Eighty-five additional leukemia cases were added as a result of the updates, bringing the total number of leukemia cases included to 225. The exposure assessment comparison resulted in changes to background exposure val-

ues. Review of source records by pathologists resulted in changes to the underlying disease subtypes for certain cases; pre-existing diseases such as myelodysplastic syndrome were often identified. Further analyses of benzene exposure and disease subtypes will be presented. This pooled study benefited from careful reconsideration of benzene exposure estimates and disease classification procedures, improving the precision of risk estimates of benzene exposure on leukemia and other disease subtypes.

T3-G.4 Schoeny R; schoeny.rita@epa.gov

US Environmental Protection Agency

INTEGRATING BIOMARKERS OF METHYL MERCURY EXPOSURE WITH DETERMINATIONS OF THE RISK ABOVE ITS RFD

The NAS (2009) report noted a need for estimating risk for noncancer endpoints, both for the purpose of estimating benefit of exposure reductions (e.g., in the context of cost-benefit analysis), and as part of harmonizing noncancer and cancer risk assessment. Methylmercury is used as a case study to investigate an approach for calculating risk for a data-rich chemical for which extensive data on biomarkers of exposure are available. An extension of the benchmark dose (BMD) method is being used. BMDs are available for the critical effect in sensitive human populations, so that the usual extrapolation issues of average humans to sensitive humans and experimental animal to humans are mollified. Instead, the data can be used directly to calculate population risk, coupled with data on the cumulative frequency of blood mercury values in women from a recent NHANES study.

M3-A.3 Schulte PA, Sofge CW; pas4@cdc.gov

National Institute for Occupational Safety and Health (NIOSH)

THE ROLE OF RISK ASSESSMENT IN PROTECTING WORKERS

The burden of occupational injury and disease is substantial, and quantitative risk assessment (QRA) can help to save lives and reduce disability of workers. U.S. estimates of occupational mortality and morbidity include approximately 55,000 deaths (eighth-leading cause) and 3.8 million disabling injuries per year, respectively, with cost burdens ranging from \$128 billion - \$155 billion. Despite the slow pace of regulatory solutions, the ability to quantify risks to workers serves to help guide decision making and consideration of the extent of risks in the workplace setting. NIOSH has conducted QRAs on a broad range of agents, including 1,3-butadiene, radiation, coal dust, hexavalent chromium, refractory ceramic fibers, manganese, silica and asbestos. Risk assessments are particularly useful for emerging hazards where the hazard and often the extent of exposure are unknown. For example, NIOSH is conducting risk assessments on two types of nanomaterials: titanium dioxide and carbon nanotubes. These risk assessments precede any epidemiologic or case reports of human health effects and yet they support the need for precautionary efforts by employers and workers to limit exposures. In the absence of a strong regulatory

approach, risk assessments, and subsequent guidance based on them, may serve as the foundation for voluntary preventive action. Still, there are many challenges that need to be addressed to further improve the value and impact of risk assessment for workers. These include further efforts to improve the utility of risk assessment; more interaction of risk assessment with toxicological and epidemiological investigators in designing research; expanded focus of risk assessment to address multiple factors that affect workforce health and safety; and further developments of risk assessment methods to address emerging hazards.

M4-H.4 Schultz MT, Toll JE, Borrowman TD, Tear L, Bridges TS; martin.t.schultz@usace.army.mil

US Army Engineer Research and Development Center

A DECISION MODEL TO SELECT BUCKET DREDGE OPERATING PARAMETERS IN AN ESTUARY WITH VALUE OF INFORMATION ANALYSIS

The environmental impacts of navigation dredging include light attenuation due to sediment resuspension, release of contaminants and nutrient to the dissolved phase of the water column, burial of benthic plant and animal communities through deposition of resuspended sediments in sensitive areas, and spreading of constituents attached to particulates. While the potential impacts of dredging are well known, the environmental costs associated with any particular dredging project are often very difficult to predict. In balancing the benefits and costs of navigation dredging projects, dredge managers must contend with a great deal of uncertainty in assessing the impacts that dredging activities will have on the environment. This paper develops a decision model to select bucket dredge operating parameters (bucket size and operating speed) in an estuary using a probabilistic network approach to account for uncertainty in eighteen different input parameters describing site characteristics. Dredging resuspension and fate and transport models incorporated into the decision model are based on those contained in the US Army Engineer Research and Development Center (ERDC) DREDGE modeling suite. Conclusions from the decision model are presented as is a general policy for selecting operating parameters given information on site characteristics. The question of whether to make a decision given available information or collect additional information is one of the key issues discussed in the risk management process. The decision model provides a basis for estimating the value of perfect information (EVPI) and the value of sample information (EVSI). Results of the value of information analysis are used to gauge the importance of gathering additional information before making a final decision, prioritize site investigation needs, and assess an upper bound on how much to invest in site investigation.

W3-D.3 Schuster BE, Demaree JD, Miller CE, Ramirez DA, Murr LE, Roszell LE; brian.e.schuster@us.army.mil

US Army Research Laboratory

CORROSION BEHAVIOR OF TUNGSTEN HEAVY ALLOYS IN RAT MUSCLE TISSUE AND IN A SIMULATED PHYSIOLOGICAL SOLUTION

We have examined the process of biodegradation and corrosion of tungsten heavy alloys (WHA) in rat muscle tissue. These studies demonstrated that the corrosion behavior of Tungsten/Nickel/Cobalt (W/Ni/Co) and Tungsten/Nickel/Iron (W/Ni/Fe) correlates strongly with their observed biological effects. Corrosion of W/Ni/Co is associated with massive degradation of the Ni and Co rich matrix material. As a consequence, implantation of this alloy in rat muscle tissue is associated with aggressive, metastatic tumors (Kalinich et al. 2005, Roszell et al. 2008). In contrast, the corrosion of W/Ni/Fe in rat muscle tissue is associated with the formation of a passive Fe-based oxide which dramatically slows the rate of corrosion. No overt adverse effects result from implantation of this alloy (Roszell et al. 2008). There is a need to rapidly assess and predict the health effects of embedded fragments of these and other alloys. Because routine corrosion testing in rat muscle tissue is impractical, we have adapted ASTM Standard corrosion tests for medical implants to assess the potential health effects of embedded fragments of these alloys. Corrosion tests of W/Ni/Co and W/Ni/Fe in phosphate buffered saline, a simulated physiological solution confirm the initial observations from in-vivo corrosion. Using this approach, we will systematically investigate the effect of composition (e.g. Fe concentration) on passivation in-vivo in WHA formulations including W, Ni, Fe and/or Co. These experiments will be used to develop a tiered approach to toxicity testing of munitions materials.

W3-A.2 Schweizer V; vschweizer@gmail.com

National Center for Atmospheric Research

SYSTEMATIC SCENARIO ANALYSIS TO CHARACTERIZE GLOBAL CATASTROPHIC RISK

Scenario analysis has long been employed to characterize vulnerabilities and risks in a variety of contexts, from war games to business strategy. However, traditional methods for scenario analysis often provide an incomplete picture of the possibility space, which can leave some risks unrecognized. This is particularly problematic when unrecognized risks are catastrophic. Complex global risks pose additional methodological challenges, as interactions between seemingly unrelated factors can exacerbate local risks or even act synergistically, giving rise to novel threats. Aside from the difficulty of amassing sufficient information to conceptualize complex catastrophic risks at the global scale, integration of information across various domains is a formidable task of its own. In this presentation, the application of the cross-

impact balance (CIB) method to scenarios characterizing global catastrophic risks will be discussed. The CIB approach is a systematic method for scenario analysis, and it explores complete, rather than partial, possibility spaces. It is also well suited for synthesizing knowledge in interdisciplinary settings. Special attention will be paid to the application of the CIB method in the context of the global catastrophic risk of climate change.

W3-A.4 Scouras J, Bennett A, Booker J, Toton E; james.scouras@jhuapl.edu

Johns Hopkins University, Georgetown University, Booker Associates, Toton Incorporated

ON ASSESSING THE RISK OF NUCLEAR WAR

The world has neither completely nor permanently escaped the specter of global nuclear war. While the nuclear arsenals of the United States and Russia are significantly lower than their Cold War levels, they still number in the thousands of weapons. Thus, there remains the possibility that deterrence might fail and these arsenals would be used. While any nuclear use would have profound implications for the United States and the international order, a global conflagration that involved the U.S. and Russian nuclear arsenals is among the most horrific catastrophes we can imagine. Because its consequences would be extreme, even a remote possibility of global nuclear war must be considered, especially when viewed over the long term, in formulating national security policy. While careful analysis of the likelihood and consequences of the failure of nuclear deterrence is not usually undertaken in developing national security strategy, general perception of the risk of nuclear war has a strong influence on the broad directions of national policy. For example, arguments for both national missile defenses and deep reductions in nuclear forces depend in no small part on the judgment that deterrence is “unreliable.” However, this judgment is usually based on intuition, rather than on a synthesis of the most appropriate analytic methods that can be brought to bear. This presentation establishes a methodological basis for more rigorously addressing the question: What is the risk of nuclear war? Our goals are to clarify the extent to which this is a researchable question, whether insights from this research might constructively inform policy, and the most promising research paths forward. We focus on assessing and integrating 4 complementary approaches: historical case study analysis, expert judgment elicitation, probabilistic risk assessment, and complex systems analysis.

M2-B.4 Seager TP, Linkov I; thomas.seager@rit.edu

Rochester Institute of Technology

A DECISION-DIRECTED APPROACH TO ENVIRONMENTAL RISKS OF NANOMATERIALS

Recent recommendations from the National Research Council with regard to environmental, health, and safety risk research advocate for close integration of research priorities with decision-maker needs. In the domain of nanomaterials, extraordinarily high variability and uncertainty makes the need for a decision-directed

approach particularly acute. Nonetheless, existing recommendations typically structure only the risk-analytic aspects of environmental research, not the decision analytic. This abstract presents a value-of-information approach to prioritizing research strategies with regard to single-walled carbon nanotubes in a product development setting. Multiple stakeholder views are modeled with respect to environmental risk information gathered from life-cycle, risk, and process perspectives, and the results synthesized in an outranking multi-criteria decision-analytic (MCDA) model.

M2-E.1 Seager TP, Mu D, Zhao F, Rao PSC; tom.seager@gmail.com

Rochester Institute of Technology

RESILIENCE OF COUPLE ECOLOGICAL-ECONOMIC SYSTEMS: BIOFUELS

Whereas traditional concepts of engineering resilience typically focus on stability, reliability or maintenance of steady-state, brittle and catastrophic failure can result in engineered systems when exogenous events such as natural disasters, acts of war or terrorism, or economic dislocations exceed the system capacity. By contrast, in ecological systems resilience is typically characterized by adaptability, flexibility and potential for regrowth. Recent experiences such as 9/11, Hurricane Katrina, and the mortgage derivatives crisis have called into question the effectiveness of traditional engineering design strategies and increased interest in the potential applicability of ecological approaches. This presentation reviews the concept of resilience as it applies in both engineering and ecological contexts, introduces design strategies and metrics for resilience and discusses the implications of a robust understanding of resilience in the context of biofuels design.

M2-H.1 Selin C; cynthia.selin@asu.edu

Arizona State University

PLAUSIBILITY REASONING AND NANOTECHNOLOGY FUTURES

Choices about emerging technologies are complicated by uncertainty: Outcomes cannot be observed until a technology is adopted, yet once path dependencies form and technologies get locked in, control becomes more difficult. Confronting this dilemma to responsibly govern technological endeavors can be aided by future-oriented research and practice. Foresight tools like scenario planning have the potential to help generate more socially robust and resilient technology pathways by systemically noticing uncertainty. Foresight involves imagination and speculation, the analytic treatment of expectations, the creation of visions and predictive models - a whole range of practices, methods and tools. However, there is little systematic scholarship that addresses the quality of such anticipatory knowledge and its relevance for decision-making. Plausibility has emerged as a crucial yet under-examined concept that critically addresses the conceptual and methodological underpinnings of future-oriented practices. In lieu of evidence and retrospective empirical studies, plausibility becomes central for addressing issues surrounding the rigor and rel-

evance of anticipatory knowledge. How scientific communities establish plausibility for technology assessment is a particularly urgent locus of concern. This talk will examine how nano-scale scientists and engineers assess plausibility. I will report on a survey conducted about future energy applications which investigated plausibility. Which resources are used to determine what is plausible? How do disciplinary perspectives, gut instinct and historical precedent weigh on determining the legitimacy of a scenario? Through the case of nanotechnology futures, the crafting of plausibility and how one scientific community approaches an assessment of future potential is explored. This work provides an empirical grounding from which to understand how plausibility judgments are made, and how epistemically robust those judgments are.

W3-E.3 Seno-Alday S; sandra.seno-alday@sydney.edu.au
The University of Sydney

A MODEL FOR ANALYSING ORGANISATIONAL RISK

The recent oil spill in the Gulf of Mexico has resulted in one of the worst environmental disasters in history, costing immeasurable loss not only to marine life but also to the livelihood and quality of life of the affected coastal communities. At the centre of this disaster is BP, one of the world's largest and most successful energy companies. Its failure to effectively mitigate this risk, prevent the disaster, quickly and effectively address the problem and contain its effects has resulted in tremendous losses to its finances, reputation and perhaps even to its medium-term viability as a business. Hence, the failure to effectively mitigate organisational risk has resulted in severely negative impacts not only at the organisational level but also at the broader socio-environmental level. This paper thus argues that effective risk mitigation at the organisational level plays a critical role in mitigating risk at the broader national and global levels. A model for a comprehensive analysis of organisational risk is proposed, which may be applied to a broad range of profit and non-profit organisations. The paper concludes with a call to employ a multi-level approach in risk analysis that more clearly brings to light the organisation as a significant player in the global risk landscape.

M4-B.3 Seo K, Tabuchi E; kamiseo2000@yahoo.co.jp
Aoyama Gakuin University

RAPID DECLINE OF AGRO-BIODIVERSITY IN JAPAN - ANOTHER "MARKET FAILURE"

Japanese agriculture and food market are at risk. Variety in cultivars is declining rapidly in Japan; for instance, we used to have hundreds kinds of radishes, though today only one represents more than 95% of the market. Even rice, the most important crop for Japanese, which is always a controversial item in WTO because of their concern, is also losing its variety. These changes have happened within only past two-three decades; parents' generation enjoyed some different kinds of radish, including Nerima, Mino and Miura. I know the name of them but have never seen

and kids' generation does not know even the existence of such variety. Issues of the decline of agro-biodiversity require different perspective from those of natural-biodiversity. Cultivated crops are manmade - varied artificially by human in long history. Today's rice in Japan, for example was brought into Japan about 2 -3 thousand years ago. Since then it has been bred to tolerate colder climates in Japan, and through that process, many different types were created. Therefore, the loss of diversity in agricultural lands is not irreversible in a scientific sense. A variety of food crops, however, is closely related with cultural diversity, which will never be restored once it has lost. There are good reasons why agro-diversity has shrunk in a short period, including introduction of hybrid, urbanization and changes in distribution system. Some changes are responses to market requests, which is natural. However, as often happens, these rapid changes "overshoot". Existence of many different types in the market provides choice for consumer. Through the choice, consumers' preference is to be informed to producers. However, if the market for a certain commodity is dominated by only a few, the market will not work properly. In this study, we review the agro-biodiversity in Japan, what is going on today. We try to reveal the social and economic mechanism and impacts of the loss of diversity in agriculture.

P.42 Sequeira RA, McDowell RM; ron.a.sequeira@aphis.usda.gov
US Department of Agriculture

INTEGRATING GLOBAL CLIMATE MODELS, EPIDEMIOLOGICAL MODELS, AND GENERAL EQUILIBRIUM ECONOMIC MODELS TO SIMULATE THE BIOLOGICAL AND ECONOMIC CONSEQUENCES OF CLIMATE CHANGE ON AGRO-ECOSYSTEM PESTS

For a variety of factors, the United States has experienced an unprecedented number of new invasive agricultural and forest pests in recent years. Climate change has also intensified the frequency and damage from several important indigenous forest pests. Climate change also threatens to make more areas suitable for exotic pests and may exacerbate the damages caused by our existing pest biota in the USA. To improve the ability of the US Dept of Agriculture to prevent and if necessary mitigate these effects we have undertaken a novel research program to link the existing models for climate (global circulation models), pest epidemiological models (both inductive and deductive), and general equilibrium economic models to generate realistic and comprehensive biological and economic assessments of the effects of climate change on crop production and pest biology under different climate change scenarios. These impact assessments will become part of a decision support system to help public managers incorporate climate change predictions into both operating and strategic plans for invasive species management.

T2-A.4 Seto EYW; seto@berkeley.edu

University of California, Berkeley

HEALTH IMPACT ASSESSMENT OF THE PORT OF OAKLAND - MOVING BEYOND HEALTH RISK ASSESSMENT

Previous health analyses of U.S. Ports have relied upon the traditional health risk assessment approach to quantify cancer and non-cancer risk. Additionally, the environmental impact assessment process has been used to evaluate the environmental effects of expansion of port operations. Both types of analyses have been narrow in scope, and have not addressed cumulative health impacts very well. Analyses have focused heavily on quantifying the risks associated with air pollution emissions. While concern over air pollution-related health impacts is warranted, there are many other ways a port can impact the health of a community, including how the presence of a port can shape key health determinants such as via transportation, land use, and labor within the community. This talk will present the results of a Health Impact Assessment (HIA) recently conducted on the Port of Oakland, which aimed to address many of the shortfalls of the previous assessments. HIA is a systematic process that can be useful in identifying the underlying baseline health conditions within a port community, pathways through which port operations can affect the health of the community, and how these pathways might act cumulatively on the health of the community as port operations grow over time. The findings of the HIA are meant to create a constructive framework that can be used by community members, port management, and city agencies to make better choices that protect and promote health. The findings of the HIA suggest the need for a broader perspective on both positive and negative ways in which a port can affect a community.

P.61 Severtson DJ; djsevert@wisc.edu

University of Wisconsin, Madison

DO MAP FEATURES CONVEY UNCERTAINTY FOR MODELED CANCER RISK FROM AIR POLLUTION? ASSESSING INFLUENCE ON RISK BELIEFS AND THE AMBIGUITY OF RISK BELIEFS

In Wisconsin, natural resources and public health professionals developed a model to estimate cancer risk based on estimated air emissions and use color-coded maps to illustrate results. The concrete nature of images such as maps may convey more certainty than warranted for modeled estimates. Cognitive testing interviews (n=3) suggested that 3 map features may convey information uncertainty: diffuse versus defined boundaries for mapped risk, relative risk versus quantified risk definitions in the legend, and one map color versus 3 colors. However, interviewees preferred feature counterparts that conveyed more certainty. The purpose of this study was to assess how these map features influenced risk beliefs and the ambiguity of beliefs for maps that displayed modeled cancer risk at four map locations. This full factorial 2x2x2x4 study (boundaries X risk definitions X map colors X map loca-

tions) used 32 maps that varied by study features and map location arranged into 8 blocks of 4 maps. Dependent variables included specific (likelihood, severity, social comparison) and global risk beliefs (problem seriousness) at personal and neighborhood levels and versions of each variable that assessed the ambiguity of risk beliefs. Covariates included numeracy, prior beliefs about air pollution, family experiences with cancer or asthma, and gender. University students in multiple classes were invited to participate in this online survey study for extra credit. After logging in, participants were randomly assigned to a block of maps and answered survey items as they viewed each map. Participants (n=827) had the following characteristics: 66.3% female, 94.8% were 18-22 years old, mean self-assessed numerical ability 4.2(1.2), family cancer experiences 32.9%, and personal asthma experience 13.4%. General linear models will be used to assess the influence of map features on risk beliefs and perceived ambiguity controlling for demographics and prior beliefs and experiences. A summary of results will be presented.

T2-C.1 Severtson DJ; djsevert@wisc.edu

University of Wisconsin, Madison

THE INFLUENCE OF PROXIMITY-BASED HAZARD ON RISK BELIEFS, EMOTION, AND RISK MONITORING AND MITIGATION INTENTIONS: COMPARING MODELED PROXIMITY-BASED HAZARD TO THE EFFECTS OF DISTANCE AND HAZARD AMOUNT

When people view maps of environmental hazards, they tend to focus on hazards near their home and community. Perceived susceptibility is based on hazard nearness and magnitude. Specific beliefs of: susceptibility, severity of associated consequences, and beliefs that one's risk is greater than others influence global risk beliefs. Global beliefs have stronger effects on behavior than specific beliefs. The purpose of this study was to assess how proximity-based hazard influences protective behavior as mediated by specific and global beliefs. Earlier research developed and assessed a model to estimate proximity-based hazard (PBH) based on distance to different hazard amounts and configurations. The current study uses 20 of 24 dot maps employed to assess the PBH model. Maps depicted water test results for private wells for a fictitious contaminant. Participants, 447 undergraduate students, were to imagine they lived at an assigned map location as they answered close-ended survey items to measure dependent variables of: specific (likelihood, severity, social comparison) and global risk beliefs (problem seriousness, concern), distress, and intentions to monitor and mitigate risk. Path analysis was used to examine the influence of PBH (compared to independent variables (IVs) of distance and hazard amount) on each behavioral intention via specific leading to global beliefs. Initial findings show that IVs of PBH or distance/amount explained the same amount of variance in monitoring (52%) and mitigation intentions (59%). Likelihood had the largest and severity the smallest total mediating effects for all path models. Hazard amount had a larger

impact on likelihood and severity than distance. Distance had a larger impact on social comparison than hazard amount. These and other results suggest how risk beliefs may differentially transmit the influences of PBH, hazard amount and distance on protective behavior. Overall, location-based susceptibility appears to have the greatest mediating influence.

P.86 Shan X, Zhuang J; jzhuang@buffalo.edu
University at Buffalo

COST OF EQUITY IN HOMELAND SECURITY RESOURCE ALLOCATION IN THE FACE OF POSSIBLE NON-STRATEGIC ATTACKERS

Hundred of billions of dollars have been spent in homeland security since September 11, 2001. Many models have been developed to study the games between governments (defender) and terrorists (attacker, adversary, enemy), but few studies consider the trade-off between equity and efficiency in homeland security resource allocation. In this paper, we develop a novel model in which a government allocates defensive resources among multiple potential targets, while reserving a portion (represented by the equity coefficient) for equal distribution (according to geographical areas, population, density, etc.). We consider that the defender is uncertain whether the terrorist is strategic (adaptive) or non-strategic; the attack probabilities of a strategic terrorist are endogenously determined in the model, while the attack probabilities of a non-strategic terrorist are exogenously provided. By varying the equity coefficient, we study the optimal defensive resource allocations among multiple targets, and the associated expected losses. We find that the cost of equity (in terms of additional expected losses) increases convexly in the equity coefficient. Furthermore, such cost decreases in: (a) the effectiveness of defense; (b) the total defense budget; and (c) the probability that the terrorist is non-strategic.

T2-G.3 Shao K, Small M; kshao@andrew.cmu.edu
Carnegie Mellon University

VALUE OF INFORMATION IN TOXICITY STUDY EXPERIMENTAL DESIGN FOR BENCHMARK DOSE ESTIMATION

The use of the Benchmark Dose (BMD) with its lower limit, the BMDL, has gradually been accepted since its introduction by Crump in 1984. For many toxicity studies, however, the traditional NOEL/LOEL standard is still the guideline for experimental design, which means experimenters are trying to determine the highest experimental dose yielding responses that no longer significantly depart from those of the concurrent control group. To develop similar protocol for experimental design for BMD estimation, methods are needed that account for variability in experimental outcomes, uncertainty in dose-response model selection, and uncertainty in model parameter values. The purpose of this paper is to propose a Bayesian method for BMD assay experimental design that uses prior information from previous toxicity studies, to design toxicological experiments which can minimize the uncertainty in

BMD and BMDL estimates. The methodology is illustrated using animal carcinogenicity study data for TCDD, addressing the number of dose groups, dose selection on a specified dose scale, and the sample size tested per dose group.

M2-A.4 Shapiro S; stuartsh@rci.rutgers.edu
Rutgers University

WHITHER LINDBLOM: CAN ANALYSIS PLAY A ROLE IN POLICY-MAKING?

More than 50 years ago, Charles Lindblom wrote, "Neither social scientists nor politicians nor public administrators yet know enough about the social world to avoid repeated error in predicting the consequences of policy moves." In the past 50 years we have attempted to defy this by implementing requirements for Environmental Impact Statements, Cost-Benefit Analysis, and many other impact analyses. When one reads assessments of the requirements that agencies conduct such analyses, one is struck by the central validity of Lindblom's argument. Analytical requirements are regularly skirted. When analyses are done, they are excessively detailed with information, sufficient to pass judicial review, but insufficient to aid in decisionmaking. Is this inevitable? Or can analytical requirements be designed differently to increase their impacts on regulatory outcomes. This paper draws on experience with NEPA, Executive Order 12866, and the Regulatory Flexibility Act to address these questions. I evaluate reform proposals and I draw conclusions about how to give an analysis an enhanced role in the policy process.

P.21 Shapiro AJ, Henning CC, Lee RM; ashapiro@icfi.com
ICF International

RECOMMENDING A BEST-FITTING MODEL USING AN EXCEL-BASED BMDS "WIZARD" FOR BENCHMARK DOSE SELECTION

A Microsoft Excel®-based toolkit (or "Wizard") has been developed that allows a user to run multiple sessions consecutively in the US Environmental Protection Agency's (EPA) Benchmark Dose Modeling Software (BMDS) and suggests best-fitting models for each session (this portion of the model is still under development). The BMDS Wizard greatly streamlines modeling sessions by menu-based automation of model selection, option file development, and output file specification. The Wizard stores data inputs, model inputs, model results, organizes BMDS output and image files, and is capable of analyzing both dichotomous and continuous endpoints. The Excel Wizard recommends a best-fitting model based upon user-defined selection criteria (primarily from EPA's 2000 Benchmark Dose Technical Guidance Draft). In this poster, we present multiple sets of model recommendation criteria, specific to the endpoint and the type of dose-response data being modeled. Examples include continuous non-cancer, dichotomous non-cancer, developmental, and cancer endpoints. In addition to model recommendation criteria, we present BMDS "session templates", including mathematical models and custom model option settings

for BMDS to evaluate. These templates can be used for rapid screening of many endpoints in order to determine which endpoints generate valid BMDLs. In addition, these session templates and model recommendation criteria may help to further standardize the benchmark dose modeling process in chemical risk assessments.

T2-B.3 Shatkin JA; jashatkin@clf.org

CLF Ventures

ENVIRONMENTAL PATHWAYS OF EXPOSURE TO ENM IN FOOD

Engineered nanomaterials can provide a range of benefits for food and are being explored for a breath of applications within and outside of the food industry. Each type of material and application presents unique exposure characteristics, directly and via environmental exposure pathways. While more diffuse than direct exposures to food additives and ingredients, environmental exposure opportunities may be an important contributor to overall risk, particularly for nanomaterials not intended for food, and must be addressed in safety and risk assessments. In this presentation, I will discuss the potential pathways, agents, data needs and uncertainties for environmental exposures to engineered nanomaterials in food.

P.49 Shay E, Thuett K, Finley B; eshay@chemrisk.com

ChemRisk, LLC

ATRAZINE IN DRINKING WATER: COMPARISON OF MEASURED AND ESTIMATED PEAK CONCENTRATIONS VS. ACUTE HEALTH BENCHMARKS

The herbicide atrazine was introduced in the U.S. in 1959 and has been applied extensively to corn, sugarcane, and soybean fields since that time. Concerns regarding potential contamination of community water systems (CWS), particularly in the Midwest, have resulted in the conduct of numerous multi-state monitoring programs, including the ongoing Atrazine Monitoring Program (AMP), which is overseen by the EPA and evaluates atrazine levels on a weekly basis during peak atrazine use (bi-weekly otherwise) for approximately 150 atrazine-vulnerable CWS. Questions have been raised as to whether the frequency of AMP sampling is sufficient to identify atrazine “peaks” that may exceed acute health-based standards. In this analysis, we compare measured atrazine concentrations in representative CWS to a range of acute (one-day) benchmarks: 1) the historical EPA standard (0.298 ppm) that is based on developmental effects, 2) a refined developmental-effects value (1.1 ppm) that incorporates updated information regarding database adequacy and body weight of pregnant women, and 3) a value based on neurological effects (5.8 ppm) that can be considered health-protective for adult males and non-pregnant women. We found that none of the AMP atrazine concentrations measured thus far exceed any of these acute benchmarks, and identified a several-fold margin of safety for a vast majority of the measurements. By applying exceedance fraction statistics, we determined that the “probability of noncompliance” with these benchmarks during

non-sampled days is very low. We also describe a variety of factors that should be considered when evaluating atrazine monitoring data in exposure and health risk assessments: use of raw vs. finished water samples, household exposure models, selection of the most appropriate monitoring database (several exist), selection of surface vs. groundwater samples, and the evaluation of atrazine metabolites.

M2-F.4 Siaw - Asamoah D; dasamoah@buffalo.edu

State University of New York at Buffalo

TRADITIONAL OR BLOGGING? RISK COMMUNICATION AND LIVING ORGAN DONATION

Organ donation is intended to improve and save lives and living organ transplant donation (LOTD) is one of two types of organ donation. Scientific innovations in medicine and technology have resulted in extraordinary advancement in living organ transplant. Although this emerging breakthrough has eliminated the many previous road blocks in donating organs, it has also created its own challenges and risks. Recent statistics show that live donations have decreased from 7000 in 2004 to 6219 in 2008 (Klein, 2010). This has resulted in a widening gap between the demand for organ and the available supply of transplants. Underlying this decrease is the issue of how risk is communicated to potential donors. This study examines the content of three traditional (governmental) and three new media (Blog) websites to determine how risk is communicated to potential live organ donors. The texts were analyzed using social learning theory (Bandura, 1994) as the framework. Given the important role of these websites in disseminating risk information to (potential) living organ donors, this paper examines their content using key concepts and insights offered by the social learning theory with particular emphasis on self-efficacy. The findings assisted in formulating research questions for future studies and health promotions. Additionally, the issue of health literacy and its influence on self-efficacy and subsequent positive behavior outcomes were discussed. Based on the results, the author recommended a medium that combines the strengths of both traditional (governmental) and new media (blog) sites to provide the best resource for future potential live donors.

T3-F.3 Siegrist M; msiegrist@ethz.ch

ETH Zurich, Switzerland

THE EFFECT OF LABELING NANOTECHNOLOGY PRODUCTS ON PUBLIC RISK AND BENEFIT PERCEPTION

Currently, there is no mandatory labeling for products containing synthetic nanoparticles. The public as well as other stakeholders have positive views toward mandatory labeling, however. The aim of the present study was to examine the effect of labeling on the perception of nanotechnology applications. We expected that participants interpret a label as an indication of possible risks associated with nanotechnology. As a result, products with a label may be perceived in a less positive way than

products without a label. Participants received different types of information about a consumer product, and we examined the effect that this information had on risk and benefit perception. Sunscreen was used in the present study for several reasons: sunscreens containing synthetic nanoparticles are already on the market, sunscreen is a familiar product, and sunscreen with synthetic nanoparticles has been perceived as more risky than other nanotechnology applications. Data were collected in a survey experiment (N = 1382). Participants were randomly assigned to one of six conditions. The control group received a picture of a sunscreen container without a label. One experimental group received a picture of a sunscreen container with a label. The other groups received in addition to the sunscreen container with a label some risk or benefit information. Results of the present research suggest that the labeling of nanotechnology consumer products may result in a higher level of perceived risks and in a lower level of perceived benefits. Labeling consumer products may, therefore, change public perception of these products. This is an unintended side effect of labeling and must be taken into account when discussing the mandatory labeling of consumer products containing synthetic nanoparticles.

W2-H.4 Siegrist J, Ferson S; jacksie@eden.rutgers.edu

Applied Biomathematics

THE AMBIGUITY OF LIFE: HOW BIOLOGY AND ECOLOGY AFFECT RISK COMMUNICATION AND DECISION MAKING

Recent findings in neuroscience suggest that a distinct calculator devoted to processing ambiguity (also known as epistemic uncertainty, incertitude, or lack of knowledge) exists in the multicameral human brain. We explore the effect that such a calculator would have, in interaction with other special-purpose calculators in the brain and suggest that several famous paradoxes in probability and decision making may arise because of the interplay of these competing calculators. Some of the phenomena that may be explained include loss aversion, ambiguity aversion and the Ellsberg Paradox, hyperbolic discounting, changing risk premiums, and certain other manifestations of human “irrationality” that have been described by psychometricians over the last several decades. We describe relevant research in foraging theory and decision making in non-human species (including plants) that place these phenomena and features in their proper biological and evolutionary context.

W4-G.1 Simmons JE, Dingus C, Wagner ED, Teuschler LK, Rice G, Plewa MJ; Simmons.Jane@epa.gov

NHEERL/ORD/US Environmental Protection Agency, NC, OH, Batelle, University of Illinois

ENVIRONMENTALLY REALISTIC MIXTURES OF HALOACETIC ACIDS EXHIBIT CONCENTRATION-DEPENDENT DEPARTURES FROM DOSE ADDITIVITY

Disinfection byproducts (DBPs), including haloacetic acids (HAAs), are formed when oxidizing disinfectants react with inorganic and organic matter in water. Drinking water is assayed routinely for 9 HAAs (HAA9): chloro-, dichloro-, trichloro-, bromo-, dibromo-, tribromo-, bromochloro-, bromodichloro-, dibromochloro- acetic acid. The first 5 (HAA5) are regulated by EPA as a mixture at 60 ug/L. Recently, iodoacetic acid (IA) was identified as a DBP. We assessed the validity of an assumption of dose addition for 7 HAA mixtures: environmentally relevant mixtures of HAA5 and HAA9 at mixing ratios representing disinfection by postchlorination or preozonation/postchlorination, and equimolar (EQ) mixtures of HAA5, HAA9 and HAA10 (comprised of HAA9 + IA). Individual HAAs and HAA mixtures were evaluated in a Chinese Hamster Ovary cell chronic cytotoxicity assay at a minimum of 10 concentrations each, ranging from 1 - 31,000 uM based on toxicity. Data were expressed as percent of the concurrent negative control. Individual HAA data were used to develop a smooth additivity model consistent with Berenbaum's definition of additivity. The slope of the fitted dose-response curve for each individual HAA and HAA mixture was negative and statistically significant, indicating that cell density decreased significantly with increasing concentration. The overall Wald test for departure from dose additivity was significant ($p < 0.001$) for each mixture. Individual dose levels of each mixture (with Hochberg's correction applied, $\alpha = 0.05$) demonstrated less-than-additive (antagonistic) departures from additivity in the higher portions of the mixture dose-response curves. Only the 5HAA EQ mixture, at the lowest two concentrations, exhibited statistically significant greater-than additive responses. In sum, deviation from additivity was concentration-dependent. The predominant mixture responses were consistent with dose addition or antagonism. (This abstract may not reflect EPA policy.)

W1-F.5 Simons RRL, Hill AA, Swart A, Snary EL; e.l.snary@vla.defra.gsi.gov.uk

Veterinary Laboratories Agency (VLA), National Institute for Public Health and the Environment (RIVM)

A TRANSPORT & LAIRAGE MODEL FOR SALMONELLA IN PIGS FOR INDIVIDUAL EU MEMBER STATES

A model for the transmission of salmonella in finisher pigs during the transport and lairage stages of the farm-to-consumption chain has been developed. This model is specifically designed with the aim of modeling potentially important risk

factors and interventions. As such, the model includes factors such as environmental contamination and the effect of stress. This model forms part of a generic farm-to-consumption EU model for salmonella in pigs and is designed to be adaptable for any EU member state (see accompanying abstract by Snary et al.). This poster describes the modeling methodology and demonstrates the parameterisation of the model for two case-study member states (MSs). For both MSs, the model predicts a small increase in the average lymph node positive batch prevalence during both transport and lairage. However, closer analysis shows that there is wide variation in the change in prevalence in individual batches, with some batches showing an increase of up to 100%. Sensitivity analysis (variation inherent in the baseline model) of the model suggests that stress is the most important factor during transport, while a number of parameters including the rate of carryover between batches of pigs and one of the dose-response parameters are important during lairage. Potential interventions during Transport & Lairage, as well as at the farm and in slaughterhouses, are considered in the abstract submitted by Hill et al. This model suggests that the transport and lairage stages of the farm-to-consumption chain can have a large effect on an individual level, potentially being the cause of a large increase in the prevalence within a batch of pigs and also providing an opportunity for previously uninfected batches of pigs to become infected. However, large individual changes at a batch level are infrequent enough to not cause a similarly large change in the average prevalence over the whole member state between farm and the point of slaughter.

M3-F4 Slovic P; pslovic@pop.uoregon.edu

University of Oregon

THE MORE WHO DIE, THE LESS WE CARE: CAN WE OVERCOME PSYCHOPHYSICAL NUMBING THROUGH EDUCATION?

Affect, attention, information, and meaning are critical to judgment and decision making about risk. We generally understand that our rapid, intuitive, affective 'System 1' and our somewhat slower, analytical, and rational 'System 2' are both involved in thinking and action. We also understand that we can more readily identify with and thus deal with individuals or very small numbers than with large numbers or populations. We call this 'psychophysical numbing' - that large numbers result in a numbing of interest and attention. This is of critical importance in addressing genocide, injuries and deaths from natural disasters, and the environmental and planetary risks associated with millions of barrels of oil, for example. It is important and even vital that the general public be made aware of and understand these attributes in our physical and psychological makeup. One approach is to personify numbers via the use of Faces and related images. This approach has been rarely used in traditional risk education and communication, although it is used extensively by the media. We will explore ideas and possibilities as to how a Faces approach might be employed in informal education environments and activities.

T2-D.4 Smid JH, Havelaar AH, Heres L, Hoek A, Swart A, Pielaat A; joost.smid@rivm.nl

National Institute for Public Health and the Environment of the Netherlands

A BIOTRACING MODEL OF SALMONELLA IN THE PORK PRODUCTION CHAIN

We define biotraceability as the ability to use down stream information to point to materials, processes or actions within a particular food chain that can be identified as the source of undesirable agents, using a model-based approach. Mathematical models using QMRA can be extended to address such questions. We discuss a biotraceability model for Salmonella in the pork slaughter chain. Concentration information of the contamination event, in combination with prior beliefs about the values of process parameter and the dynamics of Salmonella through the chain, allow making inference statements, such as "where can we expect the source of an observed case of contamination?" and "did a particular decontamination processes fail in this case?". The domain model is implemented as a Bayesian Belief Network, representing the full joint probability of the model and hence making these inferences possible. To construct the model, we used a Modular Process Risk Modeling (MPRM) approach and divided the slaughter chain into eight different modules. Data, collected in one Dutch slaughterhouse, were used to specify prior beliefs about the model inputs and to iteratively refine the distributions of the parameters in the model so that it optimally describes that specific slaughterhouse. The model can be used to trace back the source of any individual case of contamination in this slaughterhouse. Its results suggest that house flora on/in the carcass splitter was the causative source of contamination for many carcasses. The model shows the concept of biotraceability, gives insight in the chain dynamics and indicates the sites in the chain where collecting data is most effective for biotraceability. It is implemented as an interactive computer application, which can be seen as a step in the process towards an operational biotraceability system, by which a stakeholder can initiate immediate responses to hazards imposed in the pork slaughterhouse.

M4-F3 Smith N, Leiserowitz A; nicholas.smith@yale.edu

Yale University

THE ROLE OF EMOTION IN GLOBAL WARMING RISK PERCEPTIONS AND POLICY PREFERENCES

Research has identified the important role affect plays influencing perceptions of global warming risk and policy preferences. This paper considers the role of specific emotions in how global warming risk and policy options are made sense of by the American public. Data collected from a nationally representative survey found that positive and negative emotions positively predicted perception of global warming risk and support for global warming policy options above and beyond cultural worldviews, negative affect, imagery and a range of socio-demographic variables.

Worry, fear, interest and hope explained the largest proportion of variance and identify the important role emotions play tailoring how Americans feel about global warming. This not only strengthens experiential theories of how risk information is processed but also argues that perception research should move beyond assessing just the 'goodness' or 'badness' of different risks.

T4-D.3 Smith M, Anyamba A, Fanaselle W, Oryang D; david.oryang@fda.hhs.gov

NASA-GSFC, FDA-CFSAN

ASSESSING THE RISK OF PREHARVEST E. COLI CONTAMINATION OF PRODUCE USING CLIMATE AND ENVIRONMENTAL DATA

The cost of food borne E. coli illnesses has been estimated at \$344 million, and approximately 21% of all food borne E.coli outbreaks between 1982 and 2002 were the result of contaminated produce. Although the conditions leading to preharvest contamination of produce are poorly understood, results from previous studies have shown that overland water flow is one of the most important parameters influencing the movement of microbial contaminants across land surfaces. Particularly, rainfall and rainfall intensity play a significant role in the release of E. coli and other pathogens and their potential transport to cultivated fields via runoff or by entering the irrigation water supply. In this study NASA and FDA are collaborating to develop an agricultural contamination risk assessment model for E. coli based primarily on the spatial and temporal distribution of cumulative precipitation, as well as other environmental variables. Remote sensing data and historical outbreak data were combined within geographic information systems to analyze the eco-climatic conditions prior, during, and after E. coli events. Early results indicate a significant correlation between E. coli incidence and the anomaly of cumulative precipitation from the long term mean. This relationship may ultimately be used as an early warning system to monitor potential contamination of leafy green produce.

T2-D.2 Snary EL, Simons RRL, Swart AN, Vigre H, Domingues AR, Hald T, Evers E, Tennant J, Kelly L, Hill AA; e.l.snary@vla.defra.gsi.gov.uk

Veterinary Laboratories Agency (VLA), National Institute for Public Health and the Environment (RIVM), National Food Institute, Technical University of Denmark

A QUANTITATIVE MICROBIOLOGICAL RISK ASSESSMENT FOR SALMONELLA IN PIGS FOR INDIVIDUAL EU MEMBER STATES

Targets will shortly be set by the European Union (EU) for each individual Member State (MS) to reduce the prevalence of infection in pigs at slaughter. To provide a solid evidence base for target setting the European Food Safety Authority was asked to provide a scientific opinion, underpinned by a quantitative microbiological risk assessment (QMRA), funded through an Article 36 grant. The QMRA characterizes the variability both within and between EU MSs. This was achieved by developing a generic model with a clearly defined set of MS-dependent parameters.

The QMRA estimates the risk of salmonellosis and number of human cases for three product types: pork cuts, minced meat and fermented ready-to-eat sausages. The QMRA was primarily designed to investigate current and future interventions, resulting in a highly mechanistic model. The generic model was parameterised for four case study MSs. For all four MSs the average probability of illness is between 1 in 100,000 and 1 in 10 million servings given consumption of one of the three product types. The model was validated by comparing the QMRA estimated prevalence to the observed prevalence at the point of lairage and retail; the QMRA outputs were deemed to be plausible at these two points. The total number of cases attributable to the three product types was also estimated. Similar to other farm-to-consumption QMRAs the model overestimates the number of cases, which can be attributed to a variety of factors including a lack of data regarding both immunity and dose response. However, the QMRA still allows for the prediction of the relative impacts of different interventions during the Farm, Transport, Lairage and Slaughterhouse, which was the main purpose of the QMRA. The QMRA will be, where possible, used by EU MSs as part of an evidence base that will inform the design of their National Control Plans for salmonella in pigs.

W4-D.4 Soller JA; amichida@hotmail.com

Soller Environmental

APPLICATION OF THE INTERAGENCY MRA GUIDELINE FOR WATER (AMBIENT AND DRINKING)

Microbial Risk Assessment is an important tool that can be used for informing many types of management activities related to water quality. This presentation will illustrate how the Interagency Microbial Risk Assessment Guideline is compatible with a wide range of water and biosolids applications through the use of illustrative examples. These examples will encompass drinking water, recreational water, reclaimed water, and biosolids and have been conducted at the Federal, State, and local levels. For drinking water, the presentation will provide an overview of EPA's use of quantitative microbial risk assessment (QMRA) in the Ground Water Rule (2006) and the Long Term Enhanced Surface Treatment Rule (2005). For recreational water, EPA is currently developing recreational water quality criteria for publication in 2012. A summary of how QMRA is being used to consider a wide range of microbial sources will be provided. Regional examples of QMRA use for recreational water will also be presented. For reclaimed water, use of QMRA to consider treatment efficacy will be summarized, and for biosolids, EPA's Problem Formulation for Human Health Risk Assessments of Pathogens in Land-Applied Biosolids (External Review Draft 2008) will be introduced.

W3-D.1 Solyst JM; jsolyst@navigantconsulting.com

ENVIRON International

TUNGSTEN COMPOUNDS RESEARCH AND RISK ASSESSMENT

Tungsten (W) is a naturally occurring metal used in alloy manufacturing in light bulb filaments, medical devices, and in military alloys. It has received increased attention in recent years following the CDC's finding that residents of Fallon, NV had higher than normal levels of W in their serum. This coincided with the finding that after firing, tungsten from tungsten nylon munitions could solublize, leading to the potential for W to enter the environment. At the time of these events, there was a lack of reliable data on which to base an assessment of health effects following oral or inhalation exposure to tungsten. Recently, several Department of Defense laboratories have initiated projects intended to address the toxicity of tungsten studies. This workshop will address the state of the science for soluble forms of tungsten.

W4-C.1 Sorensen AD, McGill WL; asorensen@ist.psu.edu

The Pennsylvania State University

UTILIZATION OF RELIABILITY ANALYSIS FOR THE BACK CALCULATION OF AN EXPLOSIVE LOAD

Numerous papers exist dealing with the reliability of structural materials exposed to explosive and air blast loading. However, there is limited literature on the utilization of the amount of damage to a structural material to determine the blast load experienced by that material. The ability to accurately predict an experienced blast load by observing and measuring the damage to a structural material would prove useful to post blast investigators and forensic engineers; the knowledge gleaned from what has happened in the past better informs how to protect critical assets in the future. This talk presents examples of how damage to structural materials can be utilized to predict a blast load using reliability analysis of structural material properties and a known standoff distance. A graphical procedure showing how the location of multiple damaged structural materials can be used to determine a blast center is also presented. This talk will conclude with a discussion on how the results from post-blast analysis can be used to inform future risk management decisions.

T3-C.1 Sparrevik M; msp@ngi.no

Norwegian Geotechnical Institute

THE IMPORTANCE OF ADDRESSING RISK PERCEPTION AND RISK COMMUNICATION IN CONTAMINATED SEDIMENT REMEDIATION PROJECTS

The management of environmental pollution has changed considerably since the growth of environmental awareness in the late sixties. The general increased environmental concern and involvement of stakeholders in today's environmental issues may enhance the need to consider risk in a much broader context than just as a predictor of ecological hazards. Risk perception and risk communication are therefore

important aspects to address in risk based management of contaminated sediments. The results from a retrospective case study of a sediment remediation project with a high degree of social unrest in Oslo harbour, Norway correlates risk perception and perceptive factors towards the preferred disposal solution in preference to socio-demographic and participatory aspects. This contradicts to some extent towards the view that there is a sharp distinction in risk perception of experts (traditional risk estimates) and those of stakeholders (particularistic, promoting individual interests) and supports the view that stakeholders may be very well informed, adopting alternative expert opinions based on various information sources. Perceptive affective factors as transparency, openness and information are fundamental to address in a stakeholder involvement process in order to work on more technical questions such as the controllability and safety of disposal alternatives. This is advocated in a similar remediation project in Bergen, Norway where advisory groups and multi criteria analysis were used in the decision making process. The study indicates that multi criteria analysis combined with a high quality participatory process may give valuable advice for a decision maker.

P.12 Steinhardt J; jsteinha@syr.edu

Syracuse University

THE WISDOM OF CROWDS 2.0: FINANCIAL ADVICE-SEEKING AND DECISION MAKING THROUGH ONLINE SOCIAL NETWORKING

In 2005 The Motley Fool, a financial news and advice website, launched a social network called CAPS based around sharing stock recommendations. Four years after its inception, a study of the site found excess returns from its user's picks far greater than any previously measured. This study seeks to understand how members of the online community use data from the site in the making of complex, and sometimes high risk, financial decisions, through online interviews with ten of its users. The research concludes that members are using information acquired from the site in their portfolio selection process, in some cases without any additional research, and in others as a check against their own beliefs.

P.67 Sterling D, Krishen L; lkrishen@futron.com

Futron Corporation

ANALYZING RISK COMMUNICATIONS AND DECISION SCENARIOS: A CASE STUDY ADDRESSING VERY LIGHT JETS IMPACTS ON THE EMERGENT PRIVATE AIR TRAVEL INDUSTRY

Continued enhancements in aircraft design and capability will significantly change the way aircraft look and the way airports operate. The introduction of very light jets (VLJ) has been anticipated for several years and finally will become fully implemented in the coming years. VLJs are just one of the many noteworthy recent upcoming changes to the aviation transport system. The implementation of VLJs could positively benefit the business commuter while incorporating advancements in

manufacturing procedures and avionic upgrades. VLJs, through their reduced cost, leg lengths, and ability to land at shorter runways, could open up a more advantageous method of transportation to the business class, and become an increased benefit to the general public. The purpose of this study is to discuss the risks and opportunities associated with VLJs, the effects of risk communications, and the resulting decision scenarios within the on-demand-air-taxi (ODAT) industry. We assessed some of the ways that ODAT will impact private aviation. This was accomplished through surveying subject matter experts in this relatively new industry. This study revealed several findings and associated decision scenarios about VLJs and ODAT's potential future. The main theme that emerged from the results is this new industry's relative uncertainty. Additionally, there are risk communications challenges that face the ODAT and VLJ manufacturers, such as educating the public, scheduling issues, and building demand for the products. One positive outcome is that most experts agreed that the VLJ's continuing development as an aircraft will lead to future growth in ODAT. A lingering issue with the VLJ is whether it will thrive without the ODAT operator. The same question must be asked of the ODAT: "Will their business model rely on the VLJ?" To date, these answers still remain uncertain at the present time due to the global economic collapse along with the failures of some prominent ODAT corporations.

M4-I.3 Streetman SS; stevestreetman@gmail.com
DHS Domestic Nuclear Detection Office

A SCALABLE APPROACH TO ADVERSARY MODELING FOR TERRORISM RISK ANALYSIS

Estimating likelihoods for low probability, high consequence events such as chemical, biological, radiological or nuclear (CBRN) terrorism is difficult and subject to considerable uncertainty. Over the past few years competing schools of thought have advocated direct estimation of the likelihoods using subject matter experts (SME) on the one hand, and various modeling approaches such as game theory or Bayesian methods on the other. Model advocates point out that direct elicitation does not adequately reflect the behavior of an adaptive adversary who may change behavior if defensive architectures are changed. Direct elicitation advocates complain that models are not typically scalable to populate the thousands or even millions of scenarios used in a terrorism risk assessment. This presentation will describe an adversary modeling approach using multi-attribute utility functions that implements a defender-attacker-defender adversary model within a probabilistic risk assessment for low frequency, high consequence terrorism events. This approach has been implemented in support of the Department of Homeland Security Radiological and Nuclear Terrorism Risk Assessment (RNTRA). This model improves upon previous efforts because the information elicited from SMEs (model parameters) is more directly related to their expertise than direct scenario likelihood estimations.

The approach also models adversary adaptation to different defensive measures and estimates risk deflection and, to some degree, deterrence. In addition, the model is useful for supporting alternative futures analysis by postulating different potential adversaries as well as different defensive architectures.

P.48 Sunger NE, Haas CH; ns443@drexel.edu
Drexel University

RECREATIONAL WATER EXPOSURE ASSESSMENT USING TIME-LAPSE PHOTOGRAPHY

Assessing human health risk associated with recreational use requires comprehensive data on all possible exposure scenarios. But the non-swimming recreational exposures have not been fully characterized. This study quantified the exposure duration of non-swimming recreational activities using the data collected by time lapse photography. Unlike traditional survey methods (prospective-cohort studies or randomized control trials), time-lapse photographic survey allows the investigator to gather a large number of continuous observations (irrespective of the weather or time of day) without causing any obstruction to the users and with no observational bias. Cameras were employed at five recreational use sites during July-September 2008; three along small urban creeks and two along one large urban river. Electronically collected data was validated with in-person surveys and it was found that characterization of few recreational activities were mainly dependent on site accessibility and size of the water body. Statistical tests were conducted before pooling the data for a particular activity from each site. The final results were used to develop probability distributions of activity duration (hrs/day) via maximum likelihood method as: Fishing (at creeks) - Beta (mean:0.45;SD:0.25), Fishing (at river) - LN(2.75,2.59), Wading-LN(0.13,0.15), Playing - LN(0.37,0.64), Canoeing -Tri (1,2,6) and Pleasure Boating - Tri (2,3,6). The described method allows for a rapid collection of exposures and activity patterns and the results generated can be applied to develop full exposure assessment for recreational activities.

T2-D.1 Swart AN, Evers E, Simons RRL, Hill AA, Hald T; arno.swart@rivm.nl
RIVM

MODELLING OF SALMONELLA DYNAMICS IN THE PIG SLAUGHTERHOUSE

The burden of Salmonella entering pig slaughterhouses across the European Union (EU) is considered to be of public health significance. Therefore, targets will be set for each EU Member State (MS) to reduce the prevalence of Salmonella infection in pigs at slaughter. In order to meet the set target, each MS will need to develop a National Control Plan (NCP). As part of the evidence base for the development of NCPs, a Quantitative Microbiological Risk Assessment (QMRA) was funded under an Article 36 grant to support the scientific opinion required by the EU from the European Food Safety. This presentation will detail our approach to a quantitative

risk assessment for Salmonella in the pig slaughter chain. Attention will be devoted to the microbial processes involved in each of the phases during slaughter (e.g. inactivation, cross-contamination). For each of the microbial processes we describe how to incorporate variability (both over individual carcasses and over slaughterhouses), using the mathematics of recursive relations and Monte Carlo simulations. We will demonstrate the suitability of such a quantitative model for implementations of interventions in the slaughterhouse environment. Furthermore we present some results, in terms of prevalences and concentrations throughout the slaughter chain, and compare these results to data available from the literature.

M2-G.4 Swart AN, Nauta M, Evers E, Hald T, Snary E; arno.swart@rivm.nl
RIVM, VLA, Food-DTU

MODELLING PREPARATION AND CONSUMPTION OF PORK PRODUCTS

This poster describes the retail and consumer phase of the EFSA Salmonella in Pork QMRA (Quantitative Microbiological Risk Assessment, funded under an Article 36 grant to support the scientific opinion required by EFS). The food chain is modelled from retail to ingestion by the consumer. Three types of pork are considered: minced meat, pork cuts and dry cured sausages. This particular choice was made because each product represents a clear distinct hazard. Pork cuts are usually cooked well, but there is a chance of cross contamination during cutting and handling of the meat. Minced meat is thoroughly mixed, and Salmonellae may be present in the interior of hamburger patties, undercooking may occur, and Salmonellae may survive. Dry cured sausages, including all variations therein like chorizo, salami, etc., are eaten uncooked. Food preparation habits are highly variable and accurate data on daily life food handling practices are hard to obtain. We performed a literature survey and parametrised the model including the inherent variability in consumer behaviour. The output is the number of Salmonellae ingested per person per day, for each pig meat product. This output will in feed into the final model, where the risk of illness is modelled using a dose-response relation.

P.56 Tachovsky JA, Haws LC; atachovsky@toxstrategies.com
ToxStrategies, Inc.

GEOSTATISTICAL ESTIMATION OF SOIL PCDD/F TEQ USING SEQUENTIAL GAUSSIAN SIMULATION AND THE AGGREGATION OF RESULTS IN MIDLAND, MI

Extensive soil sampling has been conducted in Midland, MI to characterize dioxin and furan (PCDD/F) soil concentrations. Contamination in Midland is believed to reflect air deposition from historic sources. To predict soil TEQ in areas not specifically sampled, a 6-step analysis was performed. First the soil-sampling database was screened using principal components analysis to identify samples that reflect the influence of air deposition, and those that reflect the presence of non-deposition

sources. Next, air dispersion modeling was conducted (AERMOD) to predict TEQ deposition rates and air concentration associated with three air sources at each soil location and on a regular Cartesian grid (50 meter spacing) over the City of Midland. A regression analysis was then conducted on the paired soil concentration and air dispersion estimates. The resulting regression model was used to generate a trend for the Midland grid, and the regression residuals were modeled using a semivariogram. Similar to the approach outlined in Goovaerts et al (2009), the residuals and the semivariogram were then included in a sequential gaussian simulation and 100 TEQ estimates were generated at each point on the Midland grid. The results of the geostatistical modeling are useful for the visualization of TEQ and uncertainty associated with soil predictions. Geographic areas were then defined for the aggregation of SGS results. The 95% UCL on the mean and the 95% UCL on the median were estimated for each geographic area based on the sampling distribution of means (or medians) within each defined area. For each geographic area, the modeled UCLs were then compared to all measured soil TEQ taken within the unit. Crossplots of measured vs. modeled 95% UCL TEQ indicate that the model is conservative for nearly all geographic areas. For the few geographic areas in which the measured TEQ is higher than the 95% UCL, the difference is within 30% indicating excellent prediction.

M2-I.3 Tambe M, Jain M, Pita J, Tsai J, Ordonez F; tambe@usc.edu
University of Southern California

LESSONS LEARNED FROM DEPLOYED GAME THEORETIC SECURITY APPLICATIONS

Security at major locations of economic or political importance or transportation or other infrastructure is a key concern around the world, particularly given the threat of terrorism. Limited security resources prevent full security coverage at all times; instead, these limited resources must be deployed intelligently taking into account differences in priorities of targets requiring security coverage, the responses of the adversaries to the security posture and potential uncertainty over the types of adversaries faced. Game theory is well-suited to adversarial reasoning for security resource allocation and scheduling problems because it suggests randomized policies that mitigate a key vulnerability of human plans: predictability. Casting the problem as a Bayesian Stackelberg game, we have developed new algorithms for efficiently solving such games to provide randomized patrolling or inspection strategies; our algorithms are now deployed in multiple applications. ARMOR (Assistant for Randomized Monitoring over Routes), our first game theoretic application, has been deployed at the Los Angeles International Airport (LAX) since August 2007 to randomizes checkpoints on the roadways entering the airport and canine patrol routes within the airport terminals. IRIS, our second application, is a game-theoretic scheduler for randomized deployment of the Federal Air Marshals (FAMS) requiring

significant scale-up in underlying algorithms; IRIS was put into use to generate schedules in late 2009. Finally, GUARDS has been deployed by the TSA (Transportation Security Administration) at the Pittsburgh and LAX airports starting October 2009 for pilot evaluation with a goal of large-scale deployments across multiple airports. These applications are leading to real-world use-inspired research. This talk will outline our algorithms (often based on techniques borrowed from operations research), key research results and lessons learned.

W3-G.3 Tamrakar SB, Haas CN; sbt26@drexel.edu
Drexel University

DOSE-RESPONSE MODEL OF ROCKY MOUNTAIN SPOTTED FEVER (RMSF) FOR HUMAN

Rickettsia rickettsii is the causative agent of Rocky Mountain Spotted Fever (RMSF) and is the prototype bacterium in the spotted fever group of rickettsiae which is found in North, Central and South America. The bacterium is gram negative and an obligate intracellular pathogen. The disease is transmitted to humans and vertebrate host through tick bites; however some cases of aerosol transmission also have been reported. The onset of disease follows an infective tick bite by a week (range 2-14 days), beginning with fever, severe headache, and muscle pain followed by development of rash. The disease can be difficult to diagnose in the early stages, and without prompt and appropriate treatment, it can be fatal. This paper develops dose-response models of different routes of exposure for RMSF in primates and humans. The Beta-Poisson model provided the best fit to the dose response data of aerosol exposed rhesus monkeys, and intradermally inoculated humans (morbidity as end point of response). The average 50% infectious dose among (ID₅₀) exposed human population; N₅₀ is 23 organisms with 95% confidence limits of 1 to 89 organisms. Similarly, ID₁₀ and ID₂₀ are 2.2 and 5.0 respectively. Moreover, the data of aerosol exposed rhesus monkeys and intradermally can be pooled indicating that both the dose-response relation can be described by a single relationship. We believed that statistically there is no significant difference in the natural mode of infection (tick bite) and accidental or intentional exposure via aerosol in human.

W4-G.4 Tanaka Y, Anderson S, Sampson AR; yot3@pitt.edu
University of Pittsburgh

A TWO-STAGE DOSE-RESPONSE ADAPTIVE DESIGN METHOD FOR ESTABLISHING A PROOF OF CONCEPT

In exploratory clinical trials of drug development, searching for the true dose-response curve of a treatment agent is a challenging task due to ethical and logistic reasons. One solution to the challenges is a two-stage dose-response adaptive design where both dropping and adding treatment arms are possible between the stages. To implement such a procedure and establish evidence of dose-response or a Proof of Concept (PoC), we propose a method of extending the multiple com-

parison procedures-modeling approach (Bretz, et al., 2005) into a two-stage design. To start our procedure, we must first prespecify the candidate dose-response models and the potential levels of the doses. In the first stage, a subset of the doses and a placebo are used. In the second stage, the placebo and a set of doses are selected according to a pre-specified Adding and/or Dropping Treatment Adaptation Rule (ADTAR). In both stages, we test preliminary hypotheses to establish whether or not dose-response relationships exist. In each stage, data are assumed to be normal and independent both within and across groups. Hence, the model-associated multiple contrast test statistics follow a multivariate t-distribution under the null hypothesis of no dose-response. Weights corresponding to the dose adaptation result are computed via the ADTAR function in order to adjust statistics in Stage 2. The test results of both stages are combined to establish 'global' PoC by use of a Conditional Error Function (CEF). A pre-specified decision rule utilizes the p-values associated with the multiple contrast statistics obtained from the two stages and the CEF. Using simulations based on 10,000 trials, our method is evaluated by assessing the probability of detecting a dose-response curve, Proof of Activity (PoA), under different response shapes and sample sizes. The ADTAR approach preserved the overall type I error at a 5% level and showed robust PoA compared to both one-stage and fixed two-stage designs.

W1-F.3 Tenenhaus-Aziza F, Maffre A, Sanaa M; ftenenhaus@cniel.com
CNIEL, AFSSA, ACTILAIT

RISK-BASED APPROACH FOR MICROBIAL FOOD SAFETY IN DAIRY INDUSTRY. APPLICATION TO LISTERIA MONOCYTOGENES IN SOFT CHEESE MADE FROM PASTEURIZED MILK

Advances in the quantitative risk assessment allow using this approach for food microbiological safety. Through the example of *Listeria monocytogenes* in soft cheese pasteurized milk, the objective of the study was to validate this approach as a tool for controlling microbiological hazards in food. Based on control plans coming from the French dairy industry and a bibliographic synthesis of all the elements that can now be integrated into a quantitative risk assessment, we proposed a complete model, estimating the risk of listeriosis at the moment of consumption, taking into account the entire manufacturing process and potential sources of contamination. From pasteurization to consumption, the amplification of a initial contamination of the process environment by *Listeria monocytogenes* is simulated, over time, in space and between products, accounting for the impact of control measures, such as hygienic operations and sampling frame. A sensitivity analysis of the model allows for the identification of major parameters contributing to the risk and the optimization of preventive and corrective measures. This model, which can be adapted to other species and processes, concretely illustrates the interest of the quantitative risk assessment in food safety.

W3-G.4 Teske SS, Huang Y, Bartrand T, Tamraker S, Haas CN; ssteske@gmail.com

Drexel University

ANIMAL AND HUMAN DOSE-RESPONSE MODELS FOR PROMINENT BRUCELLA SPECIES

Brucellosis ranks number one among zoonotic diseases in the world with over half a million new cases reported every year. Disease manifestations of *Brucella* are linked to differences between the species and diversity between hosts that can affect any organ and tissue producing protean clinical symptoms, and significant morbidity, although it has low mortality rates. Ten species have been identified with *Brucella melitensis* identified as the most virulent, followed by *Br. suis* and *Br. abortus*. Because of these factors, it is classified as a Category B agent on the Centers for Disease (CDC) Bioterrorism Disease/Agents list. Candidate dose-response data extracted from literature searches underwent quality review for inclusion for maximum likelihood estimation (MLE) modeling. Binomial MLE were used to optimize the fit of the likelihood function by selecting for the best-fit of the possible parameters in order to minimize the deviances of the estimated function to the observed data. Confidence intervals to the best fit models were determined via bootstrapping with 1000 bootstrap iterations. Pooling between data sets underwent critical statistical reviews for lack of fit. Several data sets from animal tests (guinea pigs, mice, and rhesus macaques) of *Br. suis*, *Br. melitensis*, and *Br. abortus* were modeled. Effects of variable particle sizes of *Brucella* aerosol inocula on dose-response models' variation were seen. Successful pooling of dose-response models between different data sets, different animal species and different exposure routes (inhalation and subcutaneous injection) were verified. A human vaccine trial study was used to construct a time-post-inoculation (TPI) dependent model for *Brucella melitensis*. Two human outbreaks involving accidental laboratory aerosol exposures were analyzed to estimate inhalation dosages using this TPI model.

P.85 Tetsuji N, Toshinari S, Akihiko H; nishimur@nihs.go.jp

National Institute of Health and Sciences

RISK ASSESSMENT IN INTAKE FROM DRINKING WATER OF PERFLUORINATED COMPOUNDS

The per-fluorinated compounds (PFCs) commonly exist in the aquatic environment. PFCs have caused the concerns for the aquatic ecosystem and human health from their toxicity and bioaccumulation potential. In Tokyo, urban river water and ground water are used as drinking water source. We have monitored the concentrations of PFCs in water sampled from Tama River and Naka River, flowing in Tokyo of the metropolitan area, by solid-phase extraction and liquid chromatography-tandem mass spectrometry. In the optimized condition for measurement, the limits of qualification were 50 to 200 ng/L. Tama River is suitable to observe pollution

from human activity. Because, the six sewage treatment plants exist around the Tama River basin, and serve to about 2.2 million populations. PFCs were detected from every water samples receiving the load of the drainage from sewage treatment plants. The average of the total concentrations was 33.4 ng/L for PFCAs and 75.2 ng/L for PFCs in 2008. The high abundant compounds in PFCAs were perfluoronanoic acid (PFNA, 42%), perfluorooctanoic acid (PFOA, 32%), and perfluorohexanoic acid (PFHxA, 14%). The high abundant compounds in PFCs were perfluorooctanesulfonic acid (PFOS, 80%), perfluorohexanesulfonic acid (PFHxS, 16%), and perfluorobutanesulfonic acid (PFBS, 3%). U.S.EPA has set 200ng/L on PFOA and PFOS as the recommendation values. On PFOA, it becomes the measured value of river water for public use is assumed at the drinking water concentration for 0.053 for the recommendation value. On PFOS, it becomes the measured value is also assumed for 0.30. Actually, it can be assumed that these ratio decreases further, since more and more clean river water in the upstream is used for drinking water for water supply. But, the attention must be paid to an intake by the drinking water, because these compounds are difficult to remove by the water purification treatment.

P.75 Thedéen T; tort@kth.se

KTH

SAFETY NORMS OF THE SOCIETY, A GROUP OF COMPANIES AND A SPECIFIC UNIT

How should the safety norms be decided and how should they be controlled by the society or company boards? The risks often occur in hierarchical systems - the society, groups of companies and a specific unit. The norms decided upon at a higher level have to be followed at lower levels. Two risk indicators are often used: the number of fatalities during a year and the maximum probability of death for an individual in the risk population. The actual norm is a mixture of these indicators, both efficiency and risk distribution have to be considered. The norm depends on the perception and the legal tradition in the country. Some countries stress the collective risk contrary to other more concentrating on the individual risk. The control of how the norms are followed depends on the data available for estimation of the specific risk. Classical statistical methods can be used in the transportation field contrary to nuclear power where tree methods have to be used. Examples from transportation, nuclear power and introduction of new medicines are considered.

W4-C.4 Thekdi SA, Lambert JH; thekdi.s@gmail.com

University of Virginia Center for Risk Management of Engineering Systems

RISK-BASED PRIORITIES TO PROTECT TRANSPORTATION INFRASTRUCTURE CORRIDORS FROM ADJACENT COMMERCIAL AND RESIDENTIAL DEVELOPMENT

Transportation and other infrastructure corridors are increasingly vulnerable to adjacent land development. Development can compromise the performance of

corridors and increase the costs of maintaining or increasing capacities. Protecting corridors requires planning and investment in order to coordinate future land use and transportation. The costs of corridor protection and the uncertainties of cost and public perception create a need for a risk-based prioritization of where development might be most consequential. A risk-based prioritization of corridor sections across large jurisdictions can support the planning process to avoid surprise, regret, and the need for costly remedies. This paper describes methods and models to prioritize corridors that are vulnerable to land development in a ten-year horizon. The methods and models are used in several stages of a risk management process: system identification, expert elicitation, predictive modeling, comparison of alternatives, and implications for future options. The methods identify factors that contribute most to volatility and integrate diverse sources of map and other data including current and forecast population and employment, preservation, corridor geometry, land value, economic indicators. Relationships among relevant factors and the probabilities of development are integrated with Bayesian network modeling to estimate time-to-development for each census block along corridors for thousands of miles of system. The methods integrate risk and cost to prioritize census blocks for corridor protection to make strategic decisions in the planning process and build a concerted action plan among agencies and developers. The methods are demonstrated on a 5,700-mile passenger and freight network of Virginia known as the Statewide Mobility System. This study aids in development of risk-based priorities for allocating limited resources to minimize the negative impacts of land development to transportation corridors.

M2-F.1 Thompson KM; kimt@kidrisk.org

Kid Risk, Inc.

HOPE VS. FEAR: RISK ANALYSIS MEETS NEW SOCIAL MEDIA

In this Age of Risk Management, consumers need to play an active role to take charge of health information and ask questions (see www.health-insight.harvard.edu) that will help them put risks in perspective. This talk will discuss the changing nature and types of health information available to and used by consumers, the challenges that arise when consumers begin to speculate about health risks using new social media like Facebook, and the role that risk analysts will need to play to reduce fear. In the context of discussing a recent health scare, this talk will demonstrate that kids are not the only people who act as bullies, misrepresent information, and get themselves into trouble using new social media.

W4-D.5 Thran B; amichida@hotmail.com

U.S. Army

APPLICATION OF THE INTERAGENCY MRA GUIDELINE FOR AIRBORNE EXPOSURES

The U.S. Army Public Health Command (formerly Center for Health Promotion and Preventive Medicine) is responsible for establishing and maintaining risk assessment capabilities to provide comprehensive support to commanders and preventive medicine staff for managing occupational and environmental health hazards. We developed Technical Guide 316 Microbial Risk Assessment for Aerosolized Microorganisms (2009) to provide a tool to assess aerosolized microbial hazards and characterize risk as a result of environmental, occupational (i.e., laboratory accident), or intentional (e.g., terrorist) exposures. The Technical Guide outlines the considerations and steps necessary to complete a microbial risk assessment for an inhalation exposure route with emphasis on indoor environments. It is not intended to be used during an event. The framework is designed to be used as a preplanning or post-event tool for bioaerosol releases (natural, occupational or intentional). It is compatible with the Interagency Microbiological Risk Assessment Guideline. Both the Technical Guide and the Interagency Guideline define two broad categories of health risk assessments: 1) retrospective assessments that assess an event that has already occurred, and 2) prospective assessments that assess something that may occur in the future. Microbial risk assessments that are conducted to mitigate (decide mitigation goals, decide an acceptable risk for a building), confirm (decide acceptable risk for an exposed population), establish (set policy), or investigate (determine research or other priorities) are also discussed.

P.100 Ting D, Eya B, Fan A; dting@oehha.ca.gov

California Environmental Protection Agency

USE OF RISK ASSESSMENT IN AN INVASIVE SPECIES PROGRAM

We describe health risk assessment of chemicals considered for use and risk communication activities in our recently developed invasive species program. The California Department of Food and Agriculture has launched projects to combat a variety of invasive species, including European grape vine moth (EGVM), gypsy moth, glassy-winged sharp shooter, and Asian citrus psyllid. Treatment methods may include removal of fruits and infected plants, release of sterile moths, deployment of sex pheromone devices, or application of pesticides or biopesticides. In support of these efforts, we assess public health issues relating to potential exposure and toxicity. In the management of EGVM, we reviewed toxicity information of *Bacillus thuringiensis kurstaki* (Btk), sex pheromones, and inert ingredients in some pesticide products, and prepared a human health risk assessment for a sex pheromone releasing device, Isomate®-EGVM. The scientific information and assessment results generated are used in preparing environmental impact reports and communications

tools such as fact sheets and posters that are provided or presented to the residents, local government officials, local health officers and other interested parties.

T3-I.4 Tisch JS, Falkenrath R, Kelly D; jessica.tisch@nypd.org

New York City Police Department, Counterterrorism Bureau

THE NEW YORK CITY POLICE DEPARTMENT'S EFFORTS TO MITIGATE TERRORISM RISK AT PRIVATE FACILITIES

In 2009, the New York City Police Department (NYPD) published a book entitled "Engineering Security: Protective Design for High Risk Buildings" to aid the New York City building community by providing information on how to prevent and mitigate the effects of a terrorist attack on a building. Engineering Security contains two main parts: the NYPD's risk-tiering system and a set of recommendations tailored by tier level for buildings in the City. Since the book was published, many private building owners and operators have used the risk assessment tool and its associated recommendations to improve security at their facilities. This talk will share NYPD's lessons learned from using Engineering Security to frame interactions with private stakeholders.

T2-C.2 Tocalino PL, Norman JE; ptocca@usgs.gov

US Geological Survey

CONTAMINANT MIXTURES IN SOURCE WATER FROM PUBLIC-SUPPLY WELLS IN THE UNITED STATES

More than one-third of the Nation's population obtains their drinking water from public wells. The U.S. Geological Survey assessed the occurrence and composition of unique contaminant mixtures in two subsets of untreated source-water samples. Contaminant mixtures were assessed relative to individual human-health benchmarks in 383 samples in which major ions, trace elements, nitrate, radon, pesticides, and volatile organic compounds (VOCs) were analyzed. Mixtures of pesticides and VOCs also were evaluated in 814 samples, regardless of the availability of benchmarks or concentrations relative to benchmarks. Contaminants detected in source-water samples from public wells usually co-occurred with other contaminants as mixtures. About 4 percent of samples contained mixtures of two or more contaminants at concentrations greater than individual benchmarks, whereas most samples (84 percent) contained mixtures of two or more contaminants at concentrations greater than one-tenth of individual benchmarks. The most common mixtures in which contaminant concentrations were greater than one-tenth of individual benchmarks were composed of one or more trace elements (arsenic, strontium, or uranium were most common), nitrate, and (or) radon. When mixtures of organic contaminants were assessed only on the basis of detections and without regard to the availability of benchmarks, three-quarters of the organic-contaminant mixtures contained an herbicide (atrazine or simazine) or an herbicide degradate (deethylatrazine). Two-thirds of these mixtures contained chloroform, and 43 percent contained perchloroethene

or trichloroethene. The most complex mixtures were detected more frequently in samples from shallower unconfined aquifers than in samples from deeper confined aquifers. Because little is known about the potential effects associated with most mixtures, findings from this study can help human-health researchers target and prioritize toxicity assessments of contaminant mixtures.

T4-C.2 Trumbo C, Peek L, Marlatt H, Lueck M, Gruntfest E, Demuth J, McNoldy B, Schubert W; ctrumbo@mac.com

Colorado State University, Fort Collins, University of Colorado at Colorado Springs, National Center for Atmospheric Research

CHANGES IN RISK PERCEPTION FOR HURRICANE EVACUATION AMONG GULF COAST RESIDENTS, 2006-2008.

Within the field of disaster research, hurricanes present among the most challenging topics of investigation because of their unpredictability, regular occurrence, large scale, and multifaceted destructiveness. But despite the considerable research that has been conducted on the human and social dynamics surrounding hurricanes, there have been surprisingly few examinations of the manner in which individuals perceive hurricane risk. In January 2006 a mail survey was sent to households in 41 counties adjacent to the Gulf of Mexico, excluding the areas affected by hurricanes Katrina and Rita (62% response rate, $n = 824$). A follow-up panel data collection was sent in January 2008 (52% response, $n = 361$). Measures included Peacock's index of hurricane outlook, evacuation optimistic bias, dispositional optimism, and hurricane experience (among others). Paired sample t-tests ($n = 361$) were used to compare individual scores across the two-year span. Hurricane outlook, estimation of the average probability of a forced evacuation in the 2008 season, and estimation of the personal probability of a forced evacuation in the 2008 season all became more optimistic. There was no significant change in dispositional optimism. Results also show that perceiving less hurricane risk is associated with being male, older age, higher income, and general optimism. Many of these findings are consistent with risk studies involving other hazards. Having less past experience with hurricanes was also associated with perception of less hurricane risk, suggesting that the growing population of individuals who have little or no hurricane experience may underestimate the risk involved. It was also shown that perception of hurricane risk decreased following two mild hurricane seasons. Finally, both components of the optimistic bias measure became more optimistic: believing that one is less likely than others to suffer a major hurricane adjusted positively along with the increased optimism for others.

P.63 Trumbo C, Zielinski-Gutiérrez E, Harper R, Kronauge C, Evans S; ctrumbo@mac.com

Colorado State University, Centers for Disease Control and Prevention, Weld County Department of Health and Environment

ETHNICITY, RISK PERCEPTION, AND SELF-PROTECTIVE BEHAVIOR FOR WEST NILE VIRUS

The endemic state of West Nile virus (WNV) underscores the need to examine factors influencing prevention. Little is known about the manner in which individuals perceive risk for WNV, how risk perception may affect behavior, and how these processes may be conditioned on ethnic differences. This study was located in Greeley, Colorado, where WNV rates have been elevated in recent years. Data were collected using a mail survey. The four-page questionnaire (English and Spanish) was mailed to 777 residents proportionally sampled for ethnicity (Hispanic-Latino/Anglo). Aggressive follow-up and incentives were employed. 385 questionnaires were returned (50%). The questionnaire included items to apply recent findings on cognitive-affective modeling of risk perception, combined with work using ecological and proximity risk perception constructs. These elements were integrated into the Health Belief Model. The data show that older female Hispanic/Latinos engage in more protective behaviors. There is also an oppositional effect between the perceived benefits and barriers concerning protective behaviors. Further, exposure to information on WNV motivates people to take protective behavior. We see four conclusions and associated opportunities for further investigation. 1) The results support use of information to increase protective behaviors. Development and evaluation of ethnically based information intervention is needed. 2) WNV is relatively non-virulent but because of its zoonotic nature and mosquito vector transmission it can serve as a proxy for other emerging vector-borne infectious diseases. 3) There are strong contrasts on the model variables across ethnicity, showing that Hispanic-Latinos and Anglos have very different experiences with WNV.

W2-I.3 Trump B, Linkov I; bdt2011@gmail.com

Carnegie Mellon University, Army Corps of Engineers

DEPARTMENT OF DEFENSE RISK ANALYSIS AND MANAGEMENT

Encompassing nearly 19% of the national budget, the Department of Defense (DoD) faces immense scrutiny over its inability to appropriately address risk management from a financial perspective. Charged with defending the nation and frequently the executor of national foreign policy, the DoD must adequately manage risk in acquisition spending while evaluating the global environment to assess strategic risks faced by the United States military. As such, operational risk management has become the ultimate standard within military services for risk analysis and management at all levels and practices. Military services and society have both become increasingly risk averse, yet the question remains whether the DoD's risk management practices

in their current form are properly suited for their objectives or whether the DoD can learn from risk analysis practices within the civilian sector. This paper addresses this question through risk analysis and decision-making within each branch of the military and how the DoD can properly focus its risk analysis policies to better achieve its goals through operational risk management practices (ORM). Instituted by the US Army in 1991, ORM's initial goals were summed up as an attempt to reduce the number of frequently occurring on- and off-duty mishaps which directly infringed upon operational readiness at all levels. Other service departments formally implemented the use of ORM within the next several years and sought the proliferation of ORM principles as a cultural way of being, undertaken in all actions regardless of specific rank or task. Consequently, ORM has become entrenched in all military actions, ranging from off-duty activities and operational training to financial management and logistics acquisitions processes

T4-B.3 Turley AT, Marenberg AA, McVey ME, Burch DF, Davis JM; aturley@icfi.com

ICF International, US Environmental Protection Agency

IDENTIFYING INFORMATION GAPS NECESSARY TO CONDUCT A COMPREHENSIVE ENVIRONMENTAL ASSESSMENT OF NANO-SILVER DISINFECTANT SPRAYS

Part of EPA's strategy for identifying and prioritizing research to inform future assessments of nanomaterials includes the development of case studies that describe what is known and what needs to be known in order to assess the ecological and health implications of specific nanomaterial applications and uses. This presentation summarizes a case study on the use of nanoscale silver (nano-Ag) as a spray disinfectant. The study is structured following the comprehensive environmental assessment paradigm, which combines a life-cycle assessment with a traditional risk assessment. A variety of methods of nano-Ag production are reported in the literature and in patent filings, but how many of these are used on an industrial scale-or which are used most frequently in general or in the production of spray disinfectants-is unknown. It is expected that nano-Ag can be released into air, water, and soil throughout the life cycle, and that within these media, nano-Ag can be transported, transformed, and distributed in the environment. The physicochemical characteristics of nano-Ag particles play a key role in determining the behavior of nano-Ag in the environment, human and ecological exposure to and toxicity of nano-Ag, and the use and effectiveness of spray disinfectant solutions containing nano-Ag. Through environmental pathways, nano-Ag might bind to other molecules, which can affect bioavailability to both ecological receptors and humans. Bacteria and fungi readily take up nano-Ag, which is consistent with the well-known antibacterial properties of silver. Less information is available regarding the toxic effects of nano-Ag when compared to what is known about conventional silver, and no conclusive determina-

tions have been made concerning the degree to which specific particle properties or environmental properties influence nano-Ag toxicity.

W3-C.4 Turner MM, Skubisz C, Kim J; skubisz@umd.edu

University of Maryland

USING AUDIENCE TAILORING AND THEORETICALLY DERIVED MESSAGES TO IMPROVE RISK COMMUNICATION INITIATIVES

This research made use of ALERT, the Food and Drug Administration's food defense initiative, to examine the effects of message tailoring and the inclusion of theoretically derived messages on risk perception. ALERT was launched in July 2006 with the intention to raise awareness in the food industry regarding food defense issues. The initiative was designed for a general audience, including individuals in all areas of the food industry (retailers, warehouse, growers, transporters, manufacturers, processors, regulators, and packers). ALERT identifies key points that industry and businesses can use to decrease the risk of intentional food contamination at their facilities. Yet, to date, we know little if anything about the effectiveness of this and other risk communication programs. Previous research suggests that identifying and prioritizing audience segments leads to more effective risk communication. In addition, theories of attitude and behavior change (e.g., Health Belief Model, Theory of Reasoned Action, Extended Parallel Process Model) suggest that messages designed to influence attitudes, norms, perceived susceptibility, perceived severity, barriers, and benefits also lead to more effective risk communication. In this research, an experiment was conducted to study the influence of theoretically designed messages and audience tailoring on receivers' perceptions about the risk of an intentional attack on the U.S. food supply. The ALERT initiative includes a web-based training that was modified for use in this experiment. Participants completed one of four versions of the ALERT training: the original training, a training that included theory based messages, a training tailored to one of the target audience segments (retailers), or a version with both tailored and theory based messages. This presentation will provide results of the experiment and review methods to improve the communication of risk information.

T4-E.2 Unice KM, Scott PK, Paustenbach DJ; kunice@chemrisk.com

ChemRisk LLC

REVIEW OF EXPOSURE MODELS ASSESSING OUTDOOR USE OF VOLATILE CONSUMER AND INDUSTRIAL PRODUCTS

Reliable methodologies for modeling airborne exposure to volatile organic solvents in consumer and industrial products are readily available. However, models for assessing outdoor exposure to volatile chemicals in the near field are less well studied and model evaluations of outdoor approaches have infrequently been conducted. Critical differences in air speed, turbulence and temperature between the indoor and outdoor environment affect both the rate of evaporation and dispersion of these

chemicals in the breathing zone. Three approaches for modeling contaminant air dispersion in the breathing zone including a simple box model with mixing factor, multi-zone box models, and a near-field Gaussian plume model were identified and reviewed. Various approaches to evaporation rate estimation were also reviewed with emphasis on factors affecting chemical mass transfer including wind speed, surface area, temperature, vapor pressure and characteristics of the boundary layer. The sensitivity of predicted exposure concentration to each model input parameter was evaluated using Monte Carlo techniques. Temperature, exposed surface area of solvent and the orientation of the exposed individual to the direction of wind were found to be the key determinants of exposure. Wind speed was a key determinant of exposure for scenarios where the vapor generation rate was not mass transfer limited, such as drum filling where saturated head space vapor emanates during splash loading. For scenarios where wind speed affects the evaporation rate and concurrently the magnitude of near-field vapor dispersion such as tool washing with an open bucket, the importance of wind speed was less than expected. Comparison of predicted airborne concentrations for various combinations of evaporation rate and air dispersion methods showed agreement within a factor of 3 when reasonable parameter assumptions were selected for solvents including acetone, benzene, ethylbenzene, toluene, xylene and limonene.

M3-D.1 Van Doren JM, Gill V, Hammack TS, Kleinmeier D, Neil KP, Nsofor O, Parish M, Ziobro GC; jane.vandoren@fda.hhs.gov

US Food and Drug Administration, US Centers for Disease Control and Prevention

SALMONELLA IN SPICES: RISK PROFILE

Recent outbreaks associated with spices, including the 2009 outbreak of Salmonella illness traced to contamination of imported black and white pepper, led the FDA to undertake a risk profile on pathogens in spices. Developing a risk profile for hundreds of commodity - pathogen pairs posed particular challenges. Focusing on Salmonella contamination, this presentation will discuss these challenges and the strategies undertaken to tackle them. Common features of the farm-to-fork continuum for these pairs will be presented. Domestic and imported spice production and contamination will be discussed and current prevention and control strategies will be reviewed. Critical data gaps limiting our ability to quantitatively assess risk will be identified and strategies to fill these gaps will be discussed.

T2-F.2 van Wingerden AM, Kuttischreuter M, Schütz H; margot.kuttischreuter@utwente.nl

Centre for Risk and Safety Perception (iCRiSP), University of Twente

COMMUNICATING UNCLEAR RISK THROUGH THE EVIDENCE MAP: RESULTS OF AN DUTCH EXPERIMENTAL STUDY

This experimental study builds on previous research into the effects of the evidence map to communicate risks and uncertainties (see abstract Wiedemann). In a

2x3 experimental design, the effect of the mode of providing information (evidence map, a narrative text, evidence map combined with narrative text) regarding risks of Electromagnetic fields with respect to health complaints and carcinogenicity on preference, perceived reader friendliness, processing time, risk comprehension and risk perception was evaluated. The content of the provided information was identical. A combination of a between subjects design (evidence map, narrative text, evidence map plus narrative text) and within subjects design (health complaints, carcinogenicity) was made. Participants were randomly assigned to the experimental conditions (n=118). Variables were reliably measured through written questionnaires. A large majority of the participants significantly preferred the evidence map as mode of receiving unclear risk information. The findings regarding perceived reader friendliness showed that the participants judged the evidence map to be shorter, better in capturing the essential information and containing simpler sentences, whereas the text was judged to be clearer and more fluent. These results are in line with prior results obtained by Börner, Schütz and Wiedemann (2009). There was a tendency for processing time to be lower for the evidence map than for the narrative text, which is remarkable considering that the amount of information was virtually identical. There was no significant effect of mode of presentation on risk comprehension as measured by the number of knowledge questions asked immediately after reading the information, that were answered correctly. There was no significant effect on risk perception. The discussion will focus on further research questions (see abstract Börner), and the implications for the design of the evidence map to communicate unclear risk.

T3-E.4 Vedomske MA, Crowther KG; mav7t@virginia.edu

University of Virginia

IMPROVING INFRASTRUCTURE PROTECTION STRATEGIES THROUGH MODELING TRUST IN THE RISK ANALYSIS FRAMEWORK

Decision making for critical infrastructure protection and other activities is a complex combination of quantitative and qualitative elements. One aspect that has been traditionally seen as purely qualitative is the affect element, which is an emotional response to information. Critical infrastructure protection allocation problems rely on the ability to share information, which in turn builds on trust-based decision-making processes. Decision models that don't account for trust result in misleading and sub-optimal allocations. This work defines the relationship between risk and trust through a theoretical model and ontology consistent with modern literature. It stretches the boundaries of contemporary risk and decision analysis by integrating the affect principle into a value of trust calculation that can be incorporated into risk-informed decision processes for infrastructure and other decision analysis. The trust formulation process can be described within the risk analysis framework where the

trustor is the decision maker and considers using an intermediary between themselves and a threat. The intermediating person (or trustee) may mitigate some risk to the trustor. The trustee's potential risk mitigation is the action within a specific context that the trustee performs. The trust forming process is a risk tradeoff between those risks assessed for the original threat and the secondary risks posed by the trustee. The trustor choosing to use the trustee for risk mitigation is the act of trusting. An expected value of trust calculus is developed based on the expected value of perfect information. The calculus' outcome can demonstrate the tradeoff between trusting and not trusting a trustee to perform a risk mitigating task which will impact some decision outcome. This work has important implications into information sharing, critical infrastructure protection, coordinated preparedness, value propositions, and other aspects of decision analysis.

T3-H.2 Ventikos NP, Louzis KA, Koimtzoglou AN; konstantinos.lusis@gmail.com

National Technical University of Athens

SHIPWRECKS VS. ENVIRONMENT IN GREEK WATERS: CODE RED OR FUZZY ALARM?

This paper deals with the development and application of a risk analysis approach regarding the importance and fate of shipwrecks in Greece. In the past few decades the potential harmful effects of wrecks remaining on the sea bottom have been realized and the issue of dealing with them has arisen. The international community has reacted by identifying shipwrecks as sources of danger through the use of specific criteria. This fact was reflected in the International Convention of the Removal of Wrecks held in 2007 by the IMO; up to that moment there was no internationally recognized set of regulations regarding the dealing with/removal of wrecks. The methodology drafted in this paper consists of three main steps. The first step is to compile a dedicated database of shipwrecks in Greek waters. The second step focuses on the qualitative assessment of risk for each shipwreck individually through the introduction of implemented factors that have been modeled in a hierarchical fuzzy system. Finally, both the risk distribution and the respective location of the wrecks are visualized in geographic terms through the use of GIS tools to come up with realistic and self explanatory results. In effect the paper describes a holistic approach, incorporating a variety of criteria, to address the danger emerging from shipwrecks in Greece. The results can be used as the input to a decision-making process which will focus on-site assessment of high risk cases in Greek territorial waters. The paper concludes with interesting insights of the aforementioned tasks.

T4-B.4 Volpe R; rvolpe@caa.columbia.edu

Silver Nanotechnology Working Group

THE SILVER NANOTECHNOLOGY WORKING GROUP-THE ROAD TO REGISTRATION

The Silver Nanotechnology Working Group (SNWG), headquartered in Research Triangle Park, North Carolina, was formed in January, 2009 in direct response to both the challenges that companies were facing in registering new products containing silver nanoparticles with the U.S. Environmental Protection Agency (EPA) under the Federal Insecticide, Fungicide and Rodenticide Act and also increased adverse press coverage of environmental and health effects of silver nanoparticles. The SNWG is an industry effort intended to foster the collection of data on silver nanotechnology in order to advance the science and public understanding of the beneficial uses of silver nanoparticles in a wide-range of consumer and industrial products. The SNWG was instrumental in pressuring the EPA to hold a Scientific Advisory Panel (SAP) meeting on nanosilver as a first step towards registering nanosilver products. In November, 2009 the SNWG presented to the EPA SAP on Nanosilver in an effort to show that Nanoscale silver is not a new material; Nanoscale silver offers real benefits to many applications; Nanoscale silver has lower antimicrobial activity compared to many silver forms; Nanoscale silver has been registered and used in real-life for decades; and established data on key toxicity parameters exists. Based on the SAP Report, industry input and its own internal deliberations, the EPA is now positioned to set policy for nanopesticides and nanosilver by mid-2010. This presentation will summarize key interactions between the SNWG and EPA during 2010 and discuss how this EPA policy will affect not only the nanosilver industry, but the nanomaterials industry in general.

P.6 von Stackelberg KE, Zemba S, Lester R, Yatsalo B, Didenko V; kvon@erisksciences.com

E Risk Sciences, LLP, Cambridge Environmental, Inc., Obninsk State University

USE OF A SPATIAL DECISION SUPPORT SYSTEM TO INTEGRATE GIS, ENVIRONMENTAL MODELS, DECISION ANALYSIS TOOLS, AND STAKEHOLDER PREFERENCES

Environmental decisions, whether site-specific or policy evaluations, by definition require making tradeoffs among criteria of importance to stakeholders and decision makers. As the complexity and availability of environmental models and tools for site characterization grow, integrative methods are needed that synthesize and interpret analyses and results. Virtually all environmental decisions involve and benefit from some degree of GIS-based data and approaches, but while decision analysis tools have been available for some time, few directly link GIS-based data with environmental models to generate decision criteria within one analytical framework. Moreover, sustainable solutions for environmental management increasingly require

innovative approaches and a more explicit incorporation of stakeholder preferences. In this poster, we present a case study that evaluates remedial alternatives using a spatial decision support system that integrates GIS-based analyses, the results of environmental models, and stakeholder preferences within one integrated spatial decision support system. We present collaborative methods for eliciting stakeholder weights for criteria used in the larger decision analysis model to identify optimal tradeoffs for sustainable decision-making.

M3-B.2 von Stackelberg KE; kvon@erisksciences.com

E Risk Sciences, LLP

DISCUSSANT FOR DECISION SUPPORT METHODS FOR NANOMATERIALS ASSESSMENT

As an invited discussant for the Symposium "Decision Support Methods for Nanomaterial Risk Assessment and Risk Management," I will provide prepared commentary on the presentations, which will have addressed such topics as Bayesian Networks, Expert Elicitation, Multi-Criteria Decision Analysis, and Nominal Group Technique. Following this commentary there will be an opportunity for interactive discussion with the other presenters and the audience.

M4-A.3 Wagner WE; wwagner@law.utexas.edu

University of Texas School of Law

THE BAD SIDE OF BENZENE

In the infamous Benzene case, the Supreme Court imposed requirements on agency risk assessments that appear to have left permanent scars on OSHA as well as on other federal health and environmental protection agencies. Benzene is thus not simply a welcome invitation that encourages QRA, but instead it erects a series of unrealistic and undemocratic impediments to an agency's risk assessment and standard-setting effort that depart in detrimental ways from parallel, professional standards for high quality risk assessment. Specifically, under Benzene, it is not enough for agency risk assessors to develop more robust data sets, more rigorous methods for QRA, or more complete characterizations of uncertainty and variability. Instead, agency risk assessments must be largely bulletproof and provide comprehensive responses to the often hundreds of criticisms presented by stakeholders during the rulemaking process. And while the Benzene Court assured OSHA that its opinion was not intended to impose a "mathematical straightjacket" on risk assessment, the Court also made it quite clear that OSHA had better provide a strong case using QRA for why a risk is "significant" before the agency proposed a feasibility-based standard to address that risk. One subsequent appellate court approvingly summed up the crux of the Benzene opinion: "To make precise estimates [and promulgate federal standards], precise data are required." And so began the courts' counterproductive interventions that set agency risk assessors on a road full of traps and obstacles that are largely foreign to risk assessors working outside of the federal government. After exploring the vari-

ous unrealistic and counterproductive demands placed on agency risk assessments as a result of the Benzene case, the presentation will turn to how these negative impacts may be overcome or at least circumvented by OSHA to secure a safer workplace in the future.

M4-E.2 Walchuk ZM, Barker K; zwalchuk@hickorytech.net
University of Oklahoma

INTERDEPENDENCY MODELING AS A TOOL FOR ANALYZING RESOURCE SUSTAINABILITY

As available supplies of high-demand resources such as oil and clean water begin to decrease, a variety of immediate and secondary effects will be seen in the economy. The Dynamic Inoperability Input- Output Model can be used to model shortages in resource production and examine which interconnected industries will be most impacted. The model will allow decision makers to design systems which remain sustainable even as key resources are lost. Case studies illustrate the model's usefulness.

W2-D.2 Walderhaug MO, Simonetti A, Menis M; mark.walderhaug@fda.hhs.gov
Center for Biologics Evaluation & Research, US Food and Drug Administration

EFFECTS OF SHELF-LIFE CHANGES AND DEVIATIONS FROM A FIRST-IN-FIRST-OUT PROTOCOL ON STEADY-STATE LEVELS OF A STOCK AND FLOW MODEL OF THE UNITED STATES BLOOD SUPPLY

Once blood is collected it has a 42-day shelf-life. Some research has indicated that if blood is transfused closer to the time it is collected, there are better patient outcomes. We examined the impact of altering the shelf-life of blood using a stochastic stock and flow model of the U.S. blood supply that is based on three years of daily blood use as estimated from Medicare billing data and on multiple years of daily blood donation records for several regions of the U.S. Simulations were run changing the expiration date from 42 days to 35, 28, and 14 days, but keeping all other parameters of the model same. The results showed that while the total amount of blood collected and used were unchanged, the steady-state levels of the blood supply were reduced by 17%, 33%, and 66% respectively. Because blood that is further from expiration is preferred by some health care professionals, the oldest blood available is not always used first. We investigated the impact of deviations from First-in First-out (FIFO) protocol on the blood supply by randomizing the order of the last seven days of blood in queue of available blood units in model simulations. Compared to using a strict FIFO protocol for selecting blood, the non-FIFO protocol reduced the steady state level by 9%. The results give evidence that a stock and flow model of the blood supply is a useful tool for investigating potential changes in how the blood supply is managed.

W4-F.3 Wallet F, Le Brun M, Charton-Bissetta J, Musson-Genon L, Bickert H, Cabanes PA; france.wallet@edf.fr
Service des Etudes médicales EDF, France, EDF Recherche et Développement, France, Société de Calcul Mathématiques, France

ANALYSIS OF DIFFERENT QUANTITATIVE MICROBIAL RISK ASSESSMENT MODELS FOR LEGIONELLA INFECTION

Inhaling Legionella bacteria in the aerosols generated by contaminated water systems may cause legionnaires' disease and/or Pontiac fever, a milder flu-like infection. Regulations in France, as in many other countries, only concern Legionella in water. They are based on empirical data where concentrations in water were associated with epidemic episodes. Quantitative microbial risk assessment (QMRA) may help the legislator to determine suitable thresholds for risk management taking into account the environmental risk of treatments. QMRA models have been developed for Legionella infection during recent years. The aim of our study was to analyse this methodology in order to develop underlying hypotheses, identify remaining uncertainties and missing data and perform a sensitivity analysis of all the parameters of these models. The evaluation of exposure is based on measurements in water as there is no validated method for measuring Legionella in air. This step generates several levels of uncertainty: validity of measurement (sampling, method of measurement etc.), water-air transfer factor, models of dispersion, survival of the bacterium in the air etc. Human exposure data must also be taken into account: are doses cumulative? What data should be taken into account? What is the distribution of these parameters? The proposed dose-response relations are based on previous animal studies. Some models based on animal infectivity and mortality data consider legionnaires' disease and Pontiac fever to be two separate disease entities with two dose-response relationships. We discuss the validity of these hypotheses and the epidemiological data used to calibrate these models. The analysis of new scientific data, as well as the collection of more precise epidemiological data may fill the gaps in our knowledge highlighted in this study and allow a more precise evaluation of the risk for an appropriate management.

P.22 Watanabe T, Ishibashi Y, Yamamoto K; watanabe@esc.u-tokyo.ac.jp
The University of Tokyo, Tohoku Gakuin University

DOSE-RESPONSE ASSESSMENT OF INFECTION WITH LEPTOSPIRA VIA SKIN ROUTE

Leptospirosis is a zoonotic disease which often causes epidemics in tropical and subtropical developing countries. In the epidemic areas, rodents carry the causal pathogen, *Leptospira*, in their kidneys and excrete it in urine. People can be infected mainly via skin route in contact with water contaminated by the rodent urine. For the quantitative risk assessment in various water-related activities, we developed dose-response models for several serovars of *Leptospira* using published datasets on in-

fection of lab animals injected via intraperitoneal or subcutaneous routes. Three of five datasets used could be described by an exponential model assuming a constant host-pathogen interaction, while the others by a beta-Poisson model. Comparison of 10% infectious doses estimated with the developed models demonstrated that susceptibility of mice to serovar pomona was identical to that of guinea pigs and higher than that of hamsters, and that serovar icterohaemorrhagiae, known as the agent of fatal Leptospirosis (Weil's disease), was 12 times less infectious to mice than serovar autumnalis causing mild to intermediate symptoms. The developed models were applied to analyzing two epidemics of Leptospirosis occurred in agricultural areas in Thailand (around 2000) and Japan (around 1960). Using the epidemiological data reported, we estimated the doses of Leptosipora to which famers in each area were exposed during their work in paddy fields. The rough calculation based on the assumed density of mice as a carrier of this spirochete in the paddy fields indicated that famers had frequent contact with Leptospira during their field work. Nevertheless, the estimated doses were quite small and almost all famers were not invaded by the spirochete. This result means that the normal (not injured) skin structure is highly effective in preventing Leptospira invasion.

W2-B.2 Weinberg NM, Magee B, Bonnevie N, Bartee M; nadine.weinberg@arcadis-us.com

Arcadis

WEIGHT OF EVIDENCE EVALUATIONS: A COMPARATIVE ANALYSIS OF HUMAN AND ECOLOGICAL APPROACHES

Weight of evidence (WOE) evaluations are a critical component of many risk assessments. The overall goal of a WOE approach is to compile and evaluate various data and analytical results in order to overcome the inherent uncertainty associated with a complex pathway. As part of ecological risk assessment, WOE approaches attempt to integrate (either qualitatively or quantitatively) data from different endpoints as a means to evaluate often conflicting data and reduce or quantify uncertainty associated with disparate results. For example, the results of desk top studies as well as field investigations including benthic community studies, toxicity tests, and bulk sediment chemistry may all be evaluated for an individual site in an attempt to determine whether potential site-related effects to sediments are occurring. In the same way, human health evaluations for the vapor intrusion pathway also attempt to use a WOE evaluation to compile results from modeling and those collected from empirical data. Finally, toxicological studies, including the assessment of mutagenicity, use a WOE approach to combine results from multiple studies to make a final determination regarding a chemical's mode of action. In all cases, data that provide different results must be combined or analyzed to make a final decision. In this paper, we examine how WOE evaluations are used for ecological and human health risk assessments using three case studies. Similarities and differences in approaches as well as recommendations for improvements are provided.

T3-H.4 Wernstedt K, Murray-Tuite P; krisw@vt.edu

Virginia Tech

TRANSIT USER RISK PERCEPTIONS AFTER THE WASHINGTON DC METRORAIL COLLISION

The Washington DC Metrorail collision in June 2009 yielded the most casualties in DC's Metrorail history, causing the death of nine individuals and injuries to more than 70 others. This paper reports the results of a study that examines whether changes in attitudes among transit users in the 12-month period after the accident 1) influence travelers' selection of transportation modes in the near, medium, and long term; 2) alter the tradeoffs transit users are willing to make among safety, speed, frequency of service, cost, and reliability after such an incident; and 3) attenuate or sharpen over time and geographic distance from the accident. Our approach utilizes three waves of an identical web-based survey over the 12 month period, with respondents recruited through postcards handed out to transit riders at Metrorail, Metrobus, and commuter bus locations. The survey comprises questions on respondent background, behavioral responses to the accident, and preferences for alternative modes of transport, as well as a set of choice experiments. These latter provide the principle means by which we investigate the spatial and temporal attenuation with respect to mode choice and preferences for different system characteristics. To the best of our knowledge, previous studies of mode choice and system preferences in the aftermath of a major disruptive event do not exist. Our study thus provides an unusual consideration of safety in mode choice models and a systematic examination of the attenuation of intense feelings (resulting from the crash) over space and time and their role in decision making. Both can provide information to help policy makers and transit agencies plan appropriate alternative transit-based modes for captive riders. Such planning can help minimize personal economic impacts associated with the event and psychological impacts of temporary loss of connectivity.

M3-E.5 Widner TE, Le MH, Green JA; twidner@chemrisk.com

ChemRisk, LLC

FINAL RESULTS OF CDC'S LOS ALAMOS HISTORICAL DOCUMENT RETRIEVAL AND ASSESSMENT (LAHDRA) PROJECT

From 1999 to 2010, a team of scientists and engineers working for the Centers for Disease Control and Prevention (CDC) gathered information at Los Alamos National Laboratory (LANL) that was relevant to off-site releases of radionuclides and chemicals. Millions of classified and unclassified documents were reviewed and historical releases were identified. Radionuclide releases were prioritized based on annual dilution volumes required and chemicals based on usage data and published toxicity criteria. Releases before 1970 were most significant, and plutonium yielded the highest priority indices among radionuclides. Organic solvents, TNT, and uranium ranked highest among chemicals. Releases judged to be of particular importance include air-

borne plutonium, beryllium, tritium, uranium, and radioactivity from the Trinity test. Results suggest that airborne plutonium releases were much higher than officially reported. This is of particular interest because residential areas were built closer to production areas at Los Alamos than at any other U.S. nuclear site. A screening-level evaluation of plutonium facility stack releases in 1949 and 1959 yielded results that exceed limiting values (based on 1 in 100,000 added cancer risk) by factors of over 1,000. A screening assessment of five historical beryllium operations indicated that air concentrations in residential areas could have exceeded worker exposure limits, the USEPA reference concentration, and the National Emission Standard limit on 30-day average ambient concentrations. CDC is analyzing the findings of the project and will make recommendations regarding possible detailed dose reconstruction at a public meeting this fall.

P.52 Widner TE, Le MH, Shay EC, Scott PK, Thuett KA, Keenan JJ; twidner@chemrisk.com

ChemRisk, LLC

RESULTS OF AN INDEPENDENT PEER REVIEW OF POTENTIAL HEALTH RISKS FROM DIVERSION OF WATER FROM THE RIO GRANDE AS A SOURCE OF TAP WATER FOR THE SANTA FE, NEW MEXICO REGION

Scheduled to become operational in 2011, the Buckman Direct Diversion Project (BDD) will divert water from the Rio Grande as a source of tap water for the Santa Fe, New Mexico region. In response to public concerns regarding contaminants released from Los Alamos National Laboratory (LANL), which lies just west of the diversion point, the BDD Board commissioned an Independent Peer Review (IPR). The IPR team described, for technical and non-technical audiences, a critiqued synthesis of existing information and published risk analyses regarding exposure and health risk to local residents. They addressed radionuclide and chemical contaminants known to originate from LANL and from other sources. Legacy contaminants released to the (often dry) canyons on LANL property wash down to the river during storms and snow melts. Based on modern studies, up to 29 mCi of plutonium-239/240 was independently estimated to have been transported over several hours on 8 August 2006, after the Cerro Grande Fire. The IPR team built on that estimate using ratios of other contaminants found in canyon sediments to the measured plutonium. Contaminants have also been measured in ground water below LANL property, but the paucity of wells between detections and the Rio Grande prevents reliable prediction of arrival times at the river. River water measurements considered included 585 surface water samples collected between 1956 and 2010 that were analyzed for 578 different chemicals, radionuclides, and water quality parameters. Potential health risks were assessed based on levels recently measured in the Rio Grande, with and without anticipated removal by the new treatment plant, and based on measurements in the nearby Buckman well field

W4-A.4 Wiener JB; wiener@law.duke.edu

Duke University

THE TRAGEDY OF THE UNCOMMONS: CATASTROPHE, PRECAUTION, PERCEPTIONS AND POLITICS

The classic “tragedy of the commons” phenomenon plagues many shared resources, but the political economy of regulation shows that social institutions can learn and adopt effective policies, norms and institutions to overcome such tragedies. By contrast, rare extreme catastrophic events pose a less tractable challenge, to which societies and institutions respond less readily - what I will call the “tragedy of the uncommons” - such as extreme climate change, large asteroid collisions, and contamination from space. This presentation explores the political economy of precautions against uncommons risks. It suggests that risks of extreme catastrophes go underaddressed because of several factors, including: unavailability (the absence of salient early warning signals to mobilize political response); psychic numbing to mass casualties; absence of identified individual victim or villain; short-termism in business and government; and underdeterrence due to limited liability, widely spread losses, moral hazard through expected ex post relief, and/or the prospect that the catastrophe will destroy the institutions for ex post insurance or sanctions. This analysis highlights twists in the public’s perception of high-probability risks, low-probability (available) risks, and ultra-low-probability (unavailable) risks, which complicate the conventional debate over public versus expert perceptions of risk. It also helps distinguish precaution against mega-catastrophic risks from precaution against more gradual or routine risks. As societies solve their commons problems, uncommons risks become relatively more important; but in practice precautionary policies are often aimed at gradual and routine risks. This analysis points to further problems for precaution against ultra-low-probability mega-catastrophic risks: priority-setting and risk-risk tradeoffs. It seeks new ways for governance institutions to anticipate, prevent and survive rare extreme catastrophic risks.

M2-A.2 Williams RA, Ellig J; Rwilliav@gmu.edu

Mercatus Center at George Mason University

REGULATORY QUALITY FROM REGULATORY ANALYSIS

Preliminary Regulatory Impact Analyses, coupled with preambles, give stakeholders an ex ante view of what regulatory agencies believe constitutes a social problem large enough to merit a federal government rule. It also expresses why the agency believes it has legal authority to make the rule as well as an examination of multiple alternatives to see which one will solve the problem most effectively. It should explain to stakeholders the mechanism by which it’s rules will cause producers and consumers to change their behavior in a particular way (or ways) that will produce the desired result. It should also give stakeholders some idea of how much of the problem is expected to be actually solved and what it will cost society to ac-

comply with that goal. If done well, it will express where the government is missing vital information on these issues and also how it will follow up to make sure that it's working as planned. If these elements are not present, it can be argued that either there are reasons other than solving social problems that give rise to the regulation or that the agency is not well enough informed to address a problem. We argue that the absence of these elements happens in too many cases such that procedural remedies are needed to raise the bar for regulation.

P10 Williams PRD, von Stackelberg K; pwilliams@erisksciences.com
E Risk Sciences, LLP

EVALUATING THE ENVIRONMENTAL BURDEN OF DISEASE IN CANADA

Environmental exposures can make a significant contribution to health care costs and the population burden of disease. We summarize the published literature on the environmental burden of disease (EBD) in Canada and elsewhere. Available studies suggest the EBD for developed countries may range from as low as 1-5% to as high as 15-22%, depending on how EBD is calculated and defined. The wide disparity in estimates is due primarily to the use of different methodological approaches, data sets, assumptions, and units of analysis as well as the inclusion of different disease categories and environmental risk factors. Most EBD studies have also relied heavily on expert judgment to estimate the environmentally attributable fraction (EAF). For Canada, the World Health Organization estimates that 13% of the current disease burden is attributable to the environment (includes lifestyle and occupational risk factors). Others have estimated EAFs ranging from 10-30% for COPD, 26-53% for asthma, 7.5-15% for cardiovascular disease, 5-15% for cancer, and 2-10% for congenital afflictions in Canada. Some more focused studies provide good examples of how to link a specific environmental risk factor (e.g., air pollution) to specific health outcomes (e.g., mortality) using relevant population exposure and dose-response data. Some important data gaps include: (1) lack of well-defined or relevant environmental risk factors; (2) inadequate data on population-level exposures; (3) limited data on causation and dose-response relationships; (4) lack of longitudinal studies and environmental surveillance programs; (5) limited attempts to address uncertainty; (6) extensive use of expert judgment; and (7) need for improved methodologies that address complex issues (e.g., multiple exposures, gene-environment interactions). This information is intended to help facilitate future Canada- and region-specific EBD studies and to ensure the design of optimal public health intervention strategies.

W4-E.3 Williams PRD, Sahmel J, Knutsen J, Spencer J; pwilliams@erisksciences.com

E Risk Sciences, LLP, ChemRisk, Colorado School of Mines, Environmental Profiles, Inc.

ESTIMATING OCCUPATIONAL DERMAL EXPOSURES TO BENZENE

There is growing emphasis in the United States and Europe regarding quantification of dermal exposures of chemical mixtures and other substances. In this presentation, we evaluate the potential for dermal uptake of benzene from neat, aqueous, and organic liquid mixtures based on a comprehensive review and analysis of the published literature. Specifically, we summarize and/or calculate the permeability coefficient (K_p) and dermal flux of benzene for more than 50 experimental results (taken from more than dozen in vitro and in vivo studies), and assess how different factors (e.g., anatomical site, skin thickness, test species, vehicle, chemical activity) can affect the uptake of benzene through the skin. We find that the dermal flux for neat benzene was fairly consistent across in vivo studies, ranging from approximately 0.2-0.4 mg/cm²-hr (human data sets) and 0.5-0.7 mg/cm²-hr (animal data sets), except for a few outlier values. Greater variability in dermal uptake was observed for the neat benzene in vitro data sets. Observed outlier flux values for neat benzene were likely due to (1) the use of animal test species that have more permeable skin than humans, (2) study conditions that result in damage to the skin barrier, and/or (3) estimates of the evaporation rate of benzene for unoccluded skin conditions. Because few dermal absorption studies have been conducted on benzene-containing organic mixtures and aqueous solutions, and available test results are highly variable and uncertain, we recommend that estimated flux values for benzene for specific mixtures should not be used as surrogates for other mixtures. We also discuss the most appropriate applications for quantifying occupational dermal exposures to benzene and highlight important areas in need of further research.

W1-I.4 Willis HH; hwillis@rand.org

RAND Corporation

THE SCIENCE OF LISTENING: HOW UNDERSTANDING RISK PERCEPTIONS CAN LEAD TO BETTER POLICY

How people perceive the risks around them influences the choices they make about activities to pursue, opportunities to take, and situations to avoid. On-going studies of how people perceive terrorism events are improving understanding how the public responds to terrorism and how these responses lead to economic disruptions. As our understanding of these phenomena improves, how can this knowledge be used to improve public policy? This presentation describes two on-going studies that provide answers to this question. The first study is developing recommendations about how to effectively inform citizens in New Orleans of opportunities to reduce risks to their personal property from hurricane damage. The second study is apply-

ing methods of comparative risk assessment to conduct a national homeland security risk assessment. Interim results of these studies suggest ways that risk perception research can improve public policy and point to promising areas for further study.

M4-F.2 Wilson RS, Syal S, Crawford JM, Lutz J; wilson.1376@osu.edu

The Ohio State University

THE ROLE OF PUBLIC HEALTH AGENCIES IN PROTECTING THE PUBLIC FROM CLIMATE-RELATED RISKS TO HUMAN HEALTH

With global average temperatures and sea levels rising, and an increased occurrence of extreme weather events, increasing attention is being paid to understanding climate-related risks to human health. Public health agencies have the potential to play a large role in this effort to prepare and protect the public from the predicted impacts of a changing climate. However, previous research has shown that addressing climate-related health impacts is a low priority among public health agencies, despite concern over the potential impacts (Sinclair, 2009). An online survey of environmental health directors across the United States was conducted to identify the factors influencing the likelihood of an individual environmental health department taking action to protect the public from climate related health risks. Initial results indicate that the majority of environmental health directors believe the potential risks to human health are high, but that their ability to take action, and the associated effectiveness of those actions is low. Many also feel that the gap between what they know about climate related health impacts and what they need to know is large, indicating a need for improved risk communication as it relates to the potential impacts and actions. Logistic regression analysis indicates that the variable accounting for almost all of the explained variance in action is perceived risk. Specifically, despite widespread agreement that there are numerous barriers preventing an individual director from taking action (e.g., lack of financial resources, training, etc.), those directors who are concerned about the risks and perceive them be occurring locally are significantly more likely to have incorporated climate related programmatic activities in their department. The implications of the study findings for risk communication aimed at public health agency personnel, and the importance of individual factors in agency decision making will be discussed.

M4-A.2 Wilson MP; mpwilson@berkeley.edu

University of California, Berkeley

ADVANCING WORKER HEALTH AND SAFETY THROUGH CHEMICALS POLICY

The United States produces or imports 74 billion pounds of industrial chemicals for use in products and processes each day, and global chemical production is projected to double in the next 24 years. In the face of this enormous scale of chemical production, it is widely recognized that protections for workers from chemical exposures are grossly inadequate under the Occupational Safety and Health Act. OSHA

permissible exposure limits exist for only 193 of the 3,000 High Production Volume (HPV) chemicals in the U.S., for example, which are produced or imported at more than one million pounds per year. HPV chemicals constitute over 98% of chemicals in commercial use today, by volume. Many of the 82,000 substances in the inventory of the Toxic Substances Control Act have reached high levels of production despite very little information about their human and environmental health effects. Fundamentally new, integrated approaches to chemicals policy are needed that drive better information into the public, into supply chains, and into the hands of workers; that enable efficient action in the face of scientific uncertainty; that motivate new investment in green chemistry; and that account for the interrelated factors affecting health, communities, and ecosystems. This will require policies based on new perceptions of risk that depart markedly from the approaches of the previous 40 years. Many policy reform efforts currently underway are struggling to frame the contours of this new approach and would benefit from fresh thinking at the nexus of risk, exposure, and measures of effect, particularly as they relate to the occupational setting.

M4-B.5 Wilson LJ, Pelot R, Charles A; lisette.wilson@dal.ca

Dalhousie University, Saint Mary's University

UNDERSTANDING RISK AND RESILIENCE IN A SMALL-SCALE COASTAL SOCIAL-ECOLOGICAL FISHERY SYSTEM

This paper explores the relationship between risk and resilience in the context of a small-scale coastal fishery social-ecological system. The coastal area is the interface between land and sea environments, and includes the bio-physical components as well as the interactions with and between social, economic and governance factors influencing the use of the area. A social-ecological small-scale coastal fishery system is a dynamic integrated relationship between systems of nature and society, requiring a governance structure that is flexible and able to effectively respond to feedback from both social and ecological environments. The objective of resilience management is to prevent a social-ecological system from moving into an undesirable configuration and to better understand the system's ability to cope with internal and external shocks in a complex and uncertain environment. Within the social-ecological literature, although leading models tend to incorporate both social and ecological factors and to a certain extent the linkages between the two, the emphasis is usually focused on either the biological or social elements of the overall system. Similarly, risk management models also appear to focus either on the fishery (e.g. biological, ecological) or on the social aspects (e.g. economics, safety at sea). However to support a sustainable and resilient fishery, governance frameworks requires the identification of both specific and linked risks that could influence the overall functionality of the system. The two objectives of this paper are: firstly, drawing from current social-ecological literature, provide a broad overview of how factors of risk and resilience are described, their relationships and integration into governance models. Secondly, focusing specifically

on a small scale coastal fishery, present a risk management framework that incorporates the community's ability to understand and deal with local ecosystem risks, and conversely to appreciate the uncertainty surrounding the environmental consequences of their actions.

T4-C.4 Winter PL, Wilson RA, Toman E, Maguire L, Ascher TJ; pwinter@fs.fed.us
USDA Forest Service, Pacific Southwest Research Station, The Ohio State University, Duke University

ASSESSING MULTIPLE DIMENSIONS OF TRUST AMONG FEDERAL FIRE MANAGERS

Understanding the influences and dimensions of trust in the fire management context remains an important area of inquiry. The social environment surrounding fire management has received less attention than the ecological and economic dimensions (Black, Williamson, and Doane, 2008), yet managers believe trust from the public is among the most important influences in risk-related decisions (Cortner, et al, 1990). Maguire and Albright (2005) recommend trust building and collaboration as one of three remedies to excessive risk aversion, and a number of authors have reported the importance of trust in understanding public responses to fire management (see for example Cvetkovich and Winter, 2007; Winter, Vogt and McCaffrey, 2004.) In order to explore the role of trust from the perspective of federal fire managers, we conducted a web-based survey of line officers and incident personnel (n=206) in the USDA Forest Service. Preliminary analyses indicate that participants believed the public trusts the Forest Service more to protect human health and safety, protect property, and suppress fire than to protect ecosystem health or to use wildfire on lands it manages. Though most participants did not believe they shared the same values and goals for fire management as the public, perceived shared values, goals, and trust predicted greater confidence that publics would evacuate from communities when told to do so. Participants were moderately confident in their ability to make informed fire management decisions and most believed their agency shared their personal values and goals for fire management. The associations between taking risky action or behaving cautiously, and the importance of key influences in allowing a fire to burn versus engaging in suppression will be examined in light of trust. Findings help inform the continuing dialogue on trust and risk management, and help broaden this dialogue by exploring various forms of trust.

T4-G.5 Wolansky MJ; mjwolansky@gmail.com
University of Buenos Aires - Argentine National Research Council

THE GREATEST CHALLENGE IN THE RISK ASSESSMENT ARENA: IS THE CORE DILEMMA PRODUCTIVITY VS. SOPHISTICATION?

There is a long list of chemical hazards for which information from valid risk assessment (RA) studies is insufficient to elaborate well-informed, health risk management decisions. On top of that, a number of single- and multiple- chemical for-

mulations are introduced in the market every year. The challenging question is what scientists should propose to decision makers to handle the generation of sufficiently informative, opportune and predictive studies. On one side, modern RA models take time to reach a consensus in scientific arenas on reliability and usefulness, and to be accepted as valid pieces for a RA process puzzle. Then, there is a long way to go until relevant and useful findings, i.e. applicable to improve health protection in real scenarios, have the opportunity to be considered as a critical factor in the ultimate decision. In addition, too sophisticated, modern models may prove of little utility whether a urgent decision is required. Last, consequent enforcement actions will eventually take place. On the other side, several classical approaches may turn of limited utility: Most classical strategies to classify chemicals by hazard come from times when high exposures to single-chemical test materials were generally the focus of study, and LD50s the most used measures to compare potencies across chemicals in the context of a health risk ascertainment. The limited utility may be appreciated in the case of cumulative exposures to very low levels of multiple chemicals co-occurring often enough to be considered exceptional situations. In the midst of last century, a thalidomide-like teratology nightmare was a typically feared threat. Nowadays, we count with much more sensitive tools for RA. Identifying, characterizing and reducing more subtle risks of toxicity may be now considered the major goals of the ongoing RA efforts. Thinking out-of-the-box, this presentation will explore what the smartest approach would be like to work out the accumulated gap in knowledge in a cost-effective fashion and through reasonable time frames.

T2-E.1 Wood MD, Linkov I, Bridges T, Kovacs D, Thorne S, Butte G; mwood1@andrew.cmu.edu
Carnegie Mellon University, US Army Corps of Engineers Environmental Laboratory, Decision Partners, LLC

EXPERT MODELS OF USACE FLOOD RISK MANAGEMENT: ALIGNMENT OF USACE PLANNER AND ENGINEER MENTAL MODELS

Recent U.S. flooding events illustrate the importance of effectively planning for natural hazards. The U.S. Army Corps of Engineers (USACE) is the de facto leader in planning for these events because of its expertise and the many natural and manmade waterways it manages. Hurricane Katrina caused many of the systems responsible for mitigating flood risk to fail in the Gulf Coast region, and has encouraged USACE to renew interest in optimizing its flood risk management (FRM) processes. Increasing interagency coordination and stakeholder inclusion are seen as key areas for improvement.

To understand current beliefs about FRM within USACE, and to identify mechanisms for improving FRM processes, an Influence Diagram-based Mental Model approach was employed (Morgan, Fischhoff, Bostrom, & Atman, 2002). An Expert Model workshop was conducted with USACE researchers, planners, and se-

nior leadership to identify key influencing factors and to develop an expert mental model of USACE FRM. This framework was then used as the analytical basis for follow-up Mental Models interviews with USACE planners and engineers.

Several classes of influences on FRM were identified, including: factors affecting the level flood risk (e.g. weather, flood control structures); socio-economic, political, and USACE drivers that influence the quality USACE's management of that risk; and the quality of collaboration, coordination and communication within USACE and with external partners and stakeholders. Follow-up Mental Models interviews studied these areas in more depth and we will present an analysis of alignment between USACE planners' and engineers' perceptions of these influences.

W4-I.2 Woodall GM, MacDonell MM, Peshlov BN; woodall.george@epa.gov
US Environmental Protection Agency, Argonne National Laboratory

COMPARISON OF HEALTH-BASED INHALATION REFERENCE VALUES FOR ADDRESSING EXPOSURES TO ELEMENTAL MERCURY

In response to increased concerns about the effect of mercury on public health and the environment, the U.S. Environmental Protection Agency (EPA) is working together with a number of international organizations to better characterize and reduce mercury exposures. This presentation summarizes the first international inventory of health based inhalation reference values for elemental mercury. Elemental mercury is an exposure concern associated with activities ranging from increasing use of compact fluorescent lights to artisanal mining and gold processing. A general summary of the types of available reference value systems is presented first as background. The inhalation reference values for elemental mercury are then discussed in detail, including information relevant to how the values were derived, and considerations on the appropriate use of individual values. Graphical arrays are used to compare and contrast between the available health effect reference values based on type of value (emergency response, occupational, or general public), duration of exposure (acute, short-term, sub-chronic, and chronic), and severity of the health effect (ranging from none expected to lethality). More than 70 reference values have been identified for elemental mercury in air across nearly 30 countries. About two-thirds of the values are occupational, 20% for emergency response, and the rest for the general public. Within a given purpose and duration group, values tend to be generally similar (for example, emergency response values for a given duration and effect level tend to be within a factor of about two). The results of this review are being used to compare against estimates of airborne exposure levels, and to help focus ongoing efforts to mitigate exposures. [This abstract does not necessarily represent EPA policy. Mention of trade names and commercial products does not constitute endorsement or recommendation for use.]

P.105 Wright JM, Rivera-Núñez Z; wright.michael@epa.gov

US Environmental Protection Agency

THE EFFECT OF DISINFECTION BY-PRODUCTS, WATER SOURCE, AND DISINFECTION TREATMENT ON FETAL GROWTH AND PRE-TERM DELIVERY IN MASSACHUSETTS

We used birth certificate data on 672,120 infants to examine the relation between third-trimester exposures to disinfection by-products (DBPs), water source, and disinfection and mean birthweight (BWT), preterm delivery (PTD), and small for gestational age (SGA). DBP data were collected from 201 towns in Massachusetts primarily based on quarterly sampling of trihalomethanes (THM4), chloroform (CHL), bromodichloromethane (BDCM) and haloacetic acids (HAA5) from 1995-2004. Maternal third-trimester exposures were estimated from quarterly averages based on town of residence. PTD (i.e., infants born <37 gestational weeks) and SGA (i.e., infants in the lowest BWT decile stratified by gestational age at birth, infant gender, and maternal race) were assessed using logistic regression, while linear regression was used for the term BWT analyses. The regression models include adjustment for maternal age, race, education, parity, prenatal care, prenatal source of payment, median household income, smoking, marital status, source of water, and type of disinfection. We observed statistically significant mean BWT reductions of 11 g to 24 g for the upper three THM4, CHL, BDCM, HAA5 quintiles compared to those in the lowest quintile. Similar results were detected for mean BWT (14-25 g) for 20-unit THM4 intervals (21-40; 41-60; 61-80) and 15-unit HAA5 (16-23 g) intervals (1-15; 16-30; 31-45; 46-60; >60 µg/L) relative to 0 µg/L. Odds ratios (ORs) for SGA ranged from 1.05-1.15 for THM4 exposures and HAA5 exposures based on 20-unit and 15-unit exposure categories. ORs for PTD were largely null, although associations were detected between PTD and all four TCAA quintiles (Range=1.13-1.16) and the upper two BDCM quintiles (Range=0.88-0.91). Mothers using surface water systems had infants with a lower mean BWT (9 g; 95%CI: 3, 15) than those using ground water. Mothers using chloraminated water had infants with a higher mean BWT (10 grams; 95%CI: 7, 14) than those using chlorinated water. We found limited evidence of an association between specific types of disinfection and risk of SGA and PTD. Consistent with previous studies, however, we did detect small increased risks of SGA and BWT deficits associated with DBP exposures. Ongoing analyses will include examination of these exposure metrics in relation to fetal loss and birth defects.

M2-G.5 Wu C, McColl S; chloexfw@gmail.com

University of Waterloo

DEVELOPMENT OF A QUANTITATIVE MICROBIAL RISK ASSESSMENT MODEL FOR FOODBORNE E. COLI O157:H7 INFECTION: THE RISK OF CONSUMING LETTUCE

The study used a probabilistic Quantitative Microbial Risk Assessment (QMRA) framework to develop a predictive model for risk estimation for *E. coli* O157:H7 infection associated with lettuce. The model described the change of *E. coli* O157:H7 concentration in lettuce through a foodborne pathway. It consisted of a series of pathogen-associated events including initial contamination, growth during cooling, cold storage and distribution, disinfection (chlorine, gaseous chlorine dioxide and gamma irradiation), and dose response after consumption. A modified Baranyi growth model was proposed which described the initial physiological state of *E. coli* O157:H7 as a function of the initial temperature. This modified Baranyi growth model was used to predict *E. coli* O157:H7 growth under realistic time-temperature profiles, accounting for the time dynamics of temperature fluctuation. The risk assessment model was constructed in an Excel spreadsheet. Monte Carlo uncertainty analysis was simulated using Crystal Ball. The results of the current study showed temperature control was the key measure for minimizing the risk of *E. coli* O157:H7 infection associated with lettuce. Disinfecting contaminated lettuce using hypothetical methods examined in the study had limited effectiveness in risk reduction. Temperature abuse occurring before or after the hypothetical disinfections significantly diminished the disinfection effect and contributed to increased risk. The lowest risk was associated with adequate temperature control and irradiation (44 infections per 1000 consumptions [95%: 94 infection per 1,000 consumption; 5%: 5 infections per 1,000 consumption]). The model can be used to explore the public health impact of other potential strategies that can be adopted to minimize the risk of *E. coli* O157:H7, while taking into account the possible amplification of pathogen through the food chain.

W2-C.2 Wu F, Munkvold G; few8@pitt.edu

University of Pittsburgh, Iowa State University

MYCOTOXINS IN ETHANOL CO-PRODUCTS: ANIMAL AND HUMAN HEALTH IMPACTS

We estimated the health and economic impacts of a less well-known risk associated with the ethanol industry: When ethanol is produced from corn, the mycotoxins - fungal toxins - in the corn become concentrated 3 times in the co-products (dried distillers' grains plus solubles, DDGS). These co-products are not discarded, but sold to livestock industries for feed, increasing animals' mycotoxin exposure with potential livestock and even human health implications. The model developed in our work uses a case study of fumonisin, a mycotoxin common in midwest corn, and its

effect on swine growth. If there is complete market penetration of DDGS in swine feed with 20% DDGS inclusion and fumonisin is not controlled, economic losses to swine producers may reach \$300 million annually. These values represent only those losses attributable to one mycotoxin on one adverse outcome (impaired weight gain) on one species. The total loss due to mycotoxins in DDGS could be significantly higher due to additive or multiplicative effects of multiple mycotoxins on animal health. Solutions to this problem include methods to reduce mycotoxin contamination in corn, both in field and storage conditions.

W3-C.3 Yang ZJ; zyang5@buffalo.edu

State University of New York at Buffalo

TOO SCARED OR TOO CAPABLE? WHY DO COLLEGE STUDENTS STAY AWAY FROM INFORMATION ABOUT H1N1 FLU VACCINE

Although college students were among the populations that had the highest frequency of infection for H1N1 influenza, only 9% of them received H1N1 vaccine this past flu season nationwide. During the peak of this pandemic, information about H1N1 vaccine was widely available. However, knowledge test and behavioral data indicated that most college students were not equipped with basic facts about H1N1 and H1N1 vaccine. To investigate socio-psychological factors that might have deterred this high-risk population from engaging in the communication of H1N1 vaccine, this study tested the utility of a risk communication framework in addressing this health communication problem. Data collected from an online survey among 375 college students showed that risk perceptions induced negative feelings about getting the vaccine. Negative emotions, along with the tendency to act according to social norms, heightened a cognitive need for more information about this issue. This need for information subsequently led to a stronger intention for information seeking. College students who viewed information about H1N1 vaccine as believable, unbiased, and accurate were more likely to seek information and process it carefully. However, those who viewed themselves as capable to find all the information they needed were less likely to seek information, suggesting certain degree of defensive optimism. These findings suggest that to communicate to college students effectively about H1N1 vaccine, it is important to emphasize the difference between perceived knowledge and actual knowledge, monitor their emotional responses to this issue, and promote getting H1N1 vaccination as a socially desirable behavior.

W2-D.1 Yang H, Forshee R, Walderhaug M; hong.yang@fda.hhs.gov

US Food and Drug Administration

RISK ASSESSMENT OF BLOOD DONATION DEFERRAL POLICIES FOR TRAVEL TO MEXICO AND THE RISK OF TRANSFUSION-TRANSMITTED MALARIA IN THE UNITED STATES

The dominant risk of transfusion-transmitted malaria (ITM) in the US is attributed to blood donors who were prior residents of malaria endemic countries.

Current US blood donor deferral policies defer travelers to malarious regions for 1 year and immigrants from those regions for 3 years. Approximately, 61,000 blood donors are deferred every year because of travel to Mexico, however; less than 1% of malaria cases in the US are associated with these travelers. Quintana Roo, a Mexican state of major travel destination, has even lower malaria risk. FDA developed probabilistic models to evaluate the risk (ITM) and benefit (donor recovery) of removing donor deferrals for all donors who travel to Mexico (scenario 1), or only those who travel to Quintana Roo (scenario 2). The model estimates the potential number of US donors exposed to malaria and infected during travel to Mexico, and the risk reduction and donor loss due to donor deferral. Our model estimated an annual total of 16 million blood collections and 1.5 infectious (malaria-containing) blood units under current policy. The model predicted collection of an additional 109,000 units of blood, and 0.088 infectious blood units, if there was no deferral of donors who traveled to Mexico. The model predicted collection of an additional 76,000 units of blood, and 0.016 infectious blood units, if there was no deferral of donors who traveled to Quintana Roo. This risk assessment provides a tool to inform risk management decisions about transfusion-transmitted malaria risks for the US blood supply.

T2-H.1 Yaroschak PJ; Paul.Yaroschak@osd.mil
Office of the Deputy Under Secretary of Defense (IC&E)

MANAGING EMERGING CONTAMINANT RISKS: PLANS & PROGRESS

Emerging Contaminants (ECs) have no existing peer-reviewed toxicity values or health standards or the existing standards are being re-evaluated due to new science. The Department of Defense has developed a three-tiered process for over-the-horizon scanning for ECs, conducting impact assessments in five DoD functional areas, and development of risk management options. The five functional areas are: (1) Environmental, Safety and Health, (2) Mission/Readiness, (3) Acquisition, (4) Operation and Maintenance of DoD Assets, and (5) Cleanup. This presentation will describe the national and international trends related to risk assessment, analytical procedures, and overall chemical management. It will then provide an update on DoD's EC Program to include the status of DoD's EC watch and action lists, results of impact assessments, and on-going and planned risk management actions for chemicals and materials that have high risks for DoD. These risk management actions have been approved by DoD's cross-functional EC Governance Council. Attendees will become informed about the nature of risks and issues posed by ECs and DoD's initiative to address these risks and issues.

T4-H.4 Yemelyanov AM, Yemelyanov AA; ay@canes.gsw.edu
Georgia Southwestern State University

DECISION SUPPORT FOR CAUSAL ANALYSIS IN HUMAN OPERATOR ERROR INVESTIGATION

SAFE (System for Analyzing and Forecasting Errors) was developed to provide a powerful decision support tool for investigating human-operator errors and analyzing their underlying causes in complex systems (aviation, transportation, nuclear industry, etc), specifically for the situations where decision-making and risks are present. 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. SAFE provides a causal analysis of underlying factors using the proposed frame descriptions for errors with logical, decision-making, and classification algorithms, as well as the results of psychological experiments. The distinguishing feature of the suggested approach is that it presents the opportunity to logically analyze errors and their underlying factors in the process of collecting data on them, not by drawing conclusions from the investigation reports as the traditional approach. To provide the causal analysis of accidents more efficiently with meaningful recommendations on how to reduce the risk of erroneous actions occurring within a system, it is important that the corresponding classification algorithms will be working within those pre-structured factors that may influence the erroneous action. The presentation demonstrates how the classification algorithms in SAFE can be adjusted to incorporate some of the existing data-informed causal models of performance shaping factors that are used in human reliability analysis to identify the set of underlying factors and the relationships among them.

W2-B.1 Yemshanov D, Koch F, Ben-Haim Y, Downing M, Sapio F; dyemshan@nrcan.gc.ca
Natural Resources Canada

A MULTI-CRITERIA RISK MAPPING APPROACH BASED ON THE PARETO DOMINANCE-A SIMPLER ALTERNATIVE TO THE MULTI-CRITERIA WEIGHTED AVERAGING TECHNIQUE?

Risk maps for invasive species provide broad policy guidance on where to allocate resources for surveillance and regulation, but they often present individual risk aspects (such as introduction potential or climatic suitability) as separate products. Building integrated risk maps usually relies on various multi-criteria analysis techniques and requires prior knowledge of experts' perceptions of the risk components' importance. This study proposes a multi-criteria aggregation approach for building integrated risk maps that does not require knowledge of the relative importance of individual components. The technique uses the principle of Pareto dominance and analyzes the partial order of elements of a risk map in dimensions of individual risk

criteria. Integrated risk rankings are estimated as the subsequent non-dominated Pareto frontiers in dimensions of individual risk criteria. We demonstrate the approach with the example of the oak splendour beetle, *Agrilus biguttatus*, a high-risk pest that may threaten North American oak forests. Using U.S. and Canadian data, we compare the performance of the Pareto ranking against aggregation using a traditional weighted-averaging technique. We explore the performance of both methods in the presence of severe uncertainties using the concept of robustness from the information gap decision theory. The results provide a spatial representation of integrated risks and uncertainties and show major geographic hotspots where the consideration of trade-offs between multiple risk components changes integrated risk rankings. The Pareto-based aggregation can be sought as an alternative to multi-criteria weighted averaging and outranking methods when prior knowledge about the risk criteria is poor. The ordinal nature of the Pareto-based risk rankings also makes integrated maps more robust tools to prioritize risks for new or anticipated invasive species, which usually have an extremely poor prior knowledge base.

M4-H.2 Zan K, Bickel JE, Keisler JM; kzan@mail.utexas.edu

The University of Texas at Austin, University of Massachusetts Boston

LINKING VOI AND MCDA: METHODOLOGY AND APPLICATION TO PORTFOLIO DECISIONS

Information can increase the value of decisions and reduce risk. We consider how value of information (VOI) differs in the contexts of one-off vs. portfolio decisions, and in single- vs. multiple-criteria decisions. In portfolio contexts, information value depends on the uncertainty associated with each element of the portfolio, but also on the variation among the elements. In multi-criteria contexts, we assume the weights associated with each criterion are given, and each criterion has uncertain outcomes. We assume that we can learn more about each uncertainty at some cost. Since we have multiple sources of uncertainties, there are lots of combinatorial assessment plans. The VOI analysis within this context can help to decide the optimal uncertainty assessment plan under certain constrained resources, and help to the decision maker achieve the final goal of forming the optimal portfolio.

P.76 Zarayskaya IM; irina.zarayskaya@gmail.com

Russian State University for Innovation Technologies and Business

CORPORATE INNOVATION SYSTEM BASED ON HIGHER SCHOOL: THE EFFICIENCY IS HIGHER, THE RISK IS BELOW

Today, no one should be persuaded that the world market is a field of struggle for competitive advantage. Countries that have gone through economic reform, prosperity achieved only after the transition to an innovative way of development. Russia has started the innovation development in the early 90s and has not yet become a leader on this indicator among the countries. But the Russian higher education has a fairly good experience in implementing innovative programs that can be shared. It

should be noted that from approximately 1993 to 1998, the Ministry of Education of the Russian Federation together with the Russian State University for Innovation Technologies and Business (as the chief coordinator) realized a number of targeted innovative programs. Using the terminology of today these programs can be called a “breakthrough” because its showed high levels of effectiveness of innovations in different industries. Innovative programs included more than 500 innovative projects, which were attended by over 150 universities and research institutions of the country. There are still working innovative units in most of the universities. There was established the network infrastructure between universities and groups of projects. These corporate network and corporate innovation system have become an effective mechanism for financial, organizational and methodological support of small scientific and technological enterprise of higher education. Risk analysis of innovative projects implemented in universities showed a low level of risk commercialization of innovation in comparison with the innovative projects, raised in incubators, technology parks.

W2-A.1 Zeise I; lzeise@oehha.ca.gov

California Environmental Protection Agency Office of Environmental Health Hazard Assessment

ADDRESSING RISKS OF DRINKING WATER: INSIGHTS FROM THE NRC SCIENCE AND DECISIONS REPORT

The recent National Research Council (NRC) report Science and Decisions: Advancing Risk Assessment concludes that the process of regulatory risk assessment and the decision-making it supports are bogged down. It offers a variety of suggestions for research and changes in practice to improve the process. These include approaches for framing the decision-making and scoping the scientific work to support the decision; cumulative risk assessment, emphasizing enhancing its utility for discriminating among options for decision-making; approaches for dose response; and addressing data sparse chemicals. The presentation reflects on the NRC suggestions and recommendations in the in the context of addressing risks from drinking water.

P.54 Zelenka MP, Barr DB, Nicolich MJ, Lewis RJ, Bird MG, Letinski DJ, Metcalf SW, O’Lone RB; r.jeffrey.lewis@exxonmobil.com

ExxonMobil Biomedical Sciences Inc, Emory University, COGIMAT, Agency for Toxic Substances and Disease Registry, ILSI Health and Environmental Sciences Institute

A WEIGHT OF EVIDENCE APPROACH FOR SELECTING EXPOSURE BIOMARKERS FOR BIOMONITORING

A valid biomarker of exposure links the biomarker in the subject to a specific environmental exposure. When there is an array of possible biomarkers there is a need to select the optimum biomarker for the specific exposure. We have developed a Framework for scoring the appropriateness of a biomarker based on the expert solicitation approach. The Framework is based on interpretive criteria developed at a workshop co-sponsored by the Health and Environmental Science Institute. The

criteria form the basis for determining the most scientifically supportable biomarker and sample matrix for a given exposure question. Using the Framework an assessor can determine the optimum biomarker based on the consensus of experts each using the same criterion. To facilitate the use of the Framework, we have developed a computer based modeling tool to guide the researcher and experts through the process, yielding not only the relative scores, but a catalog of the responses that support the scores. The advantage of the catalog is that the experts' scores for the criteria are available for discussion. We will present the Framework electronically for attendees to test the usefulness and flexibility of the modeling tool. The default example will be a demonstration of benzene exposure, addressing the question, "what is a good marker for occupational benzene exposure through all routes over an 8-hr work shift that exceeds a concentration time-weighted average (TWA) of 1 ppm?" We provide the experts scores for six biomarkers of benzene exposure that are among those commonly used. The Framework provides for the first time a transparent, reproducible account of expert opinions in selecting the most scientifically supportable exposure marker to address a specific question. Additionally, it assists experts in identifying key data gaps about specific biomarkers and enables the consistent application of criteria to facilitate an assessment and discussion about the optimum selection.

P.55 Zemba SG, Ames MR, Linkov I, Palma-Oliveira J; zemba@cambridgeenvironmental.com

Cambridge Environmental Inc, Carnegie Mellon University and U.S. Army Engineer Research and Development Center, FP-University of Lisbon, Lisbon, Portugal

CAN DIOXIN SOURCES BE DIFFERENTIATED BY CONGENER PROFILES, AND DOES IT MATTER?

Risk assessments of polychlorinated dibenzo(p)dioxins and furans (PCDD/Fs) emitted from combustion sources typically focus on the seventeen 2,3,7,8- chlorine substituted congeners. The relative prevalence of these congeners can vary by orders of magnitude in both emissions and ambient environmental media. The U.S. EPA has noted profile differences among various source groups contained in its emission inventory. One noted distinction is an apparent congener profile difference in the emissions of Portland Cement manufacturing facilities that utilize hazardous waste fuel vs. those that do not. Conceptually, these differences could be useful in source identification studies (allowing for congener-specific fate and transport processes). However, since the U.S. EPA averaged data from different facilities in each group, it is unclear whether the observed differences reflect the influence of burning hazardous waste, or are due to other facility-specific factors. We have analyzed a substantial data set of PCDD/F measurements from two cement kilns that occasionally use hazardous waste fuels. These data indicate no substantial hazardous waste-dependent differences in PCDD/F congener profiles or emissions, an important finding with regard to stakeholder concerns about increased risk. Further examination of the U.S.

EPA data suggests facility-specific differences in PCDD/F profiles that are independent of the use of hazardous waste fuel, as well as substantial variability among trials for a single facility. Collectively, these data indicate no specific effect due to hazardous waste combustion. Interestingly, the goal of source identification, using measured source profiles, may be moot for many facilities as the PCDD/F emission levels are so low that the projected incremental impacts to ambient concentrations are dwarfed by background levels. This implies that monitoring studies that attempt to verify risk assessment predictions may be futile.

P.44 Zemba SG, Ames MR; zemba@cambridgeenvironmental.com
Cambridge Environmental Inc.

CONSIDERING POTENTIAL HEALTH RISKS IN THE DESIGN OF NOVEL SOLID WASTE MANAGEMENT FACILITIES

Until recently, landfills and waste-to-energy (WTE) facilities were the two basic technologies available to process residual (non-recycled) municipal solid waste. These technologies both have advantages and drawbacks, and their relative merits have been debated repeatedly. Risk assessments of both technologies have been used to examine their potential threats to human health and the environment, and have found that both landfills and WTE facilities can be operated in an environmentally acceptable manner. Neither alternative, however, has gained general public acceptance, and planned or existing facilities are often controversial. For example, there remains considerable skepticism that landfill liners will be effective over long periods of time, and a general uneasiness over the emissions from waste combustion. The interest in emerging conversion technologies, such as gasification and anaerobic digestion, as an alternative to conventional landfills and WTE facilities is thus understandable. However, there are some concerns that the environmental and potential public health impacts of these novel conversion technologies are not well understood, as no commercial facilities exist in the United States. Our presentation will set forth an initial risk assessment framework for assessing the risks of some novel waste conversion technologies, focusing on the likely impacts of emissions and residuals, and using available data to characterize their potential health risk impacts. Our goal is to identify likely sources of risk for waste conversion facilities based on what we know about demonstration projects and similar processes, and thus to allow risk assessment to be factored into facility design so that potential risks to human health and environment may be averted.

M3-I.4 Zhao J, Gift J; zhao.jay@epa.gov

US Environmental Protection Agency

USE OF DEVELOPMENTAL TOXICITY DATA IN THE DERIVATION OF AN RFD/RFC: APPLICATION OF U.S. EPA'S BENCHMARK MODELING SOFTWARE (BMDS)

Developmental toxicity data are commonly presented in a format of nested structure, which provides more information than regular dichotomous data. BMDS has been used routinely to model nested data in order to account for intralitter correlations and litter-specific covariates and to identify a point of departure for calculating risk values. This presentation will focus on current practice used by US EPA in using BMDS in analyzing the nested developmental data for chemical risk assessment. Examples of data analyses will be presented along with the decision making process during a data analysis.

W4-E.1 Zwack LM, Levy JI; lzwack@hsph.harvard.edu

Harvard School of Public Health

USING ADVANCED DISPERSION MODELS AND MOBILE MONITORING TO CHARACTERIZE THE CONTRIBUTION OF TRAFFIC TO SPATIAL PATTERNS OF ULTRAFINE PARTICLES IN BROOKLYN, NY

Evaluation of the public health benefits of mobile source control strategies requires an understanding of the relationship between traffic emissions and concentrations. In urban settings with elevated bridges, depressed roadways, and other complex terrain, this relationship is highly variable and difficult to model accurately. Continuous real-time monitoring of pollutant concentrations has been conducted, but generally at a limited number of locations without the ability to characterize source contributions or spatial patterns across a neighborhood. Atmospheric dispersion models are more commonly used in this context, but characterizing emissions at high resolution is challenging, especially for pollutants such as ultrafine particles, and many dispersion models do not perform well in complex terrain. The goal of this study is to compare regression models derived from mobile air pollutant monitoring observations collected in Brooklyn, NY with outputs from the Quick Urban & Industrial Complex (QUIC) model, a computational fluid dynamics-like model that can take into account the presence of buildings. The regression models characterized concentrations as a function of real-time traffic volume, meteorological variables, and distance from two major roadways. The QUIC model demonstrated similar concentration gradients to our regression model; displaying a steeper initial decline over the first 100 m. Examination of two-dimensional surfaces with both models demonstrates non-uniform patterns related to building configuration and source heights. Our comparison also allows for estimation of roadway emission rates through the best-fit relationship between regression model and QUIC outputs. Our application

of novel techniques for analyzing monitoring data and applying advance dispersion models provides insight about source contributions above background levels and spatiotemporal air pollution patterns in urban areas, useful for analyzing the benefits of control strategies.

AUTHOR INDEX

A

Abbott LC 28, 52
 Abkowitz MD 22, 68
 Acuna Mohr B 28, 134
 Akhtar R 20, 52
 Akihiko H 24, 178
 Alarcon S 30, 156
 Allen Catellier JR 35, 37, 52, 122
 Allen M 28, 126
 Altemose B 20, 52
 Alvarez P 24, 137
 Amekudzi A 28, 53
 Ames MR 23, 195
 Anderle de Saylor M 32, 147
 Andersen MA 16, 53
 Anderson B 17, 83
 Anderson CL 30, 77
 Anderson ME 30, 110
 Anderson S 39, 177
 Andrade JD 19, 53, 54
 Andrijic E 28, 54
 Anissimov M 29, 54
 Anter M 19, 54
 Anton WR 39, 54
 Anyamba A 30, 173
 Aoyagi-Usui M 31, 55
 Arnold SM 18, 23, 55
 Arvai J 21, 37, 68, 152
 Arvai JL 33, 116
 Arvidson KB 34, 56
 Ascher TJ 30, 190
 Atapattu A 32, 56
 Atkins M 29, 160
 Augustsson A 24, 56
 Avens HJ 36, 57
 Avery J 31, 75
 Ayers TL 20, 57, 74

B

Backer L 25, 109
 Bacon A 23, 101
 Bailey A 22, 57

Bailey J 35, 39, 88, 128
 Bailey LA 24, 149
 Bailey M 39, 85, 88
 Ball N 18, 55
 Bana e Costa CA 24, 143
 Barker K 20, 130, 185
 Barone S 31, 75
 Barr DB 23, 194
 Barrett SM 32, 57
 Barrett T 33, 96
 Bartee M 34, 186
 Bartels M 18, 55
 Bartlett J 36, 83
 Bartolo D 23, 117
 Bartrand T 37, 178
 Bass N 27, 58
 Bastaki M 22, 58, 109
 Batz M 20, 107
 Baum SD 36, 38, 58
 Baun A 18, 99
 Bayrak E 33, 96
 Bayramov AA 24, 59
 Beall P 36, 157
 Beane-Freeman L 25, 109
 Beard SD 17, 83
 Beaudrie CEH 36, 59
 Beaulieu SM 30, 110, 140
 Becker RA 29, 32, 59
 Behr JG 21, 86
 Belova A 18, 98
 Belzer RB 16, 60
 Ben-Haim Y 24, 60, 193
 Bennett A 36, 166
 Bennett SP 29, 60, 72, 116
 Bergbäck B 24, 56
 Berglund J 22, 109
 Bernhard T 34, 159
 Berube DM 17, 29, 60
 Besley JC 20, 24, 61
 Bickel JE 21, 194
 Bickert H 39, 185
 Bier VM 17, 26, 62
 Biksey TM 34, 62

Binder AR 16, 35, 37, 62, 67, 68
 Bird MG 23, 194
 Bittner C 32, 94
 Black E 33, 153
 Black P 30, 35, 140, 148
 Blazquez C 24, 137
 Blount B 25, 109
 Boerner F 27, 63
 Bogen KT 24, 63
 Bolka B 22, 65
 Bonnevie N 34, 186
 Boogaard PJ 23, 55
 Booker J 36, 166
 Borrowman TD 21, 165
 Borsuk ME 38, 96
 Bostrom A 19, 24, 29, 32, 63, 162
 Boudier FB 16, 18, 64
 Bouhnik AD 35, 84
 Bourdon SE 31, 64
 Bowles EA 28, 30, 64, 110
 Boyd AD 25, 37, 65
 Boyle LN 34, 154
 Braddy J 30, 87
 Branch R 25, 109
 Brass B 39, 88
 Brenner AT 17, 83
 Bridges TS 21, 26, 165, 190
 Brigham Schmuhl N 16, 35, 67, 68
 Brody T 22, 33, 65, 135
 Bronfman N 24, 110
 Brossard D 28, 37, 62, 78
 Brown PD 32, 65
 Bruine de Bruin W 16, 91
 Buckley B 22, 112
 Budinsky RA 16, 53
 Bukowski R 33, 153
 Burch DF 23, 30, 32, 66, 135, 181
 Burger J 22, 23, 66
 Burkhardt W 30, 87
 Burns C 18, 55
 Burnsteel C 30, 87
 Burns WJ 33, 67, 96
 Butler KM 25, 67

Butte G 22, 26, 119, 190
 Bye A 24, 117

C

Cabanes PA 39, 185
 Cabrera V 25, 67
 Cacciatore MA 16, 35, 67, 68
 Campbell V 35, 37, 68
 Camp JS 22, 68
 Canady R 26, 69
 Canis L 21, 69, 126
 Cantor K 25, 109
 Cao Y 24, 31, 69, 70
 Cardenas CA 22, 38, 70, 127
 Caron JD 31, 64
 Carvalho J 38, 144
 Carvalho RG 38, 144
 Casman EA 22, 34, 95, 138
 Chakraborty S 35, 70
 Chang EJ 25, 71
 Chang F 22, 119
 Chan SH 17, 71
 Charles A 20, 189
 Charron D 23, 37, 151
 Charton-Bissetta J 39, 185
 Chaudhry Q 16, 90
 Checknita D 31, 71
 Cheesebrough T 29, 72
 Cheeseman M 34, 56
 Chen C-C 35, 72
 Chen PC 22, 106, 125, 145
 Chen RS 25, 121
 Chen Y 18, 72
 Choi CW 24, 73
 Cifuentes LA 23, 73
 Clarkson JR 29, 160
 Cleland JC 23, 135
 Clewell HJ 21, 73
 Cole BL 26, 73
 Cole D 20, 57, 74
 Coleman ME 28, 74
 Coleman P 37
 Coles JB 25, 111

Collins MB 38, 92
 Collinson S 30, 156
 Conolly RB 16, 74
 Cooke RM 16, 38, 75, 90
 Cooper EJ 36, 83
 Corales M 18, 98
 Corner A 38, 75
 Cornerly O 34
 Cote I 31, 75
 Cousins AC 17, 38, 71, 75
 Cowan E 34, 91
 Cox T 27, 76
 Cragin DW 33, 76
 Crawford JM 21, 189
 Cretu O 38, 76
 Cretu V 38, 76
 Crossley R 30, 156
 Crowther KG 28, 183
 Crump KS 16, 77
 Cuite CL 36, 102
 Cullen AC 30, 77
 Culpepper J 31, 123
 Cummings CL 37, 77
 Cunningham FH 22, 78
 Cura 34
 Curtright AE 16, 160
 Cyterski M 33, 135

D

Dady JM 30, 98
 Dagonneau J 33, 153
 Dalrymple KE 28, 78
 Dana GV 30, 78
 Daron J 23, 134
 Davidson A 31, 129
 Davidson RA 26, 124
 Davidson VJ 20, 154
 Davies GJ 39, 79
 Davis A 9, 19
 Davis HL 17, 83
 Davis JA 19, 79
 Davis JM 16, 30, 80, 128, 181
 Davis ME 31, 32, 80

- Davis TB.....27, 32, 79, 81
Dearfield K.....38, 81
Decker DK.....19, 81
Dederick EJ.....23, 32, 57, 135
De la Maza C.....23, 73
Deleris L.....20, 98
Delgado J.....37, 81
Delisio E.....22, 65
Demaree JD.....36, 165
Demuth JD.....24, 30, 82, 180
Dennis SB.....30, 87, 110
Desprez-Loustau ML.....23, 150
Devlin K.....18, 160
Devlin R.....31, 75
Didenko V.....22, 184
Dilworth CH.....17, 83
Dingus C.....39, 171
Ditmer R.....35, 102
Ditmer RD.....35, 115
Dix D.....31, 75
Dodge DG.....24, 149
Domesle AR.....17, 71
Domingues AR.....26, 173
Donoso FJ.....23, 73
Donovan EP.....32, 147
Dorey RA.....30, 156
Douglas HE.....17, 82
Dourson M.....25, 146
Downing M.....193
Doyle EA.....34, 82
Drew CH.....17, 83
Drews F.....19, 83
Driedger SM 20, 36, 37, 83, 109, 158
Dueñas-Osorio L.....34, 157
Durkee S.....39, 85
Dutt V.....21, 84
- E**
- Edwards JM.....39, 54
Edwards S.....31, 75
Effio D.....24, 84
Egolf BP.....36, 92
Einsiedel EF.....25, 65
Eisinger F.....35, 84
Ellig J.....16, 27, 85, 187
- Engle M.....39, 85, 88
Eosco GM.....30, 85
Estrin AJ.....28, 134
Evans AM.....24, 85
Evans D.....20, 98
Evans J.....33, 153
Evans MV.....21, 86
Evans S.....23, 181
Evensen DTN.....25, 86
Evers E.....17, 26, 33, 105, 106,
.....173, 175, 176
Eya B.....24, 179
Ezell BC.....21, 86
- F**
- Falkenrath R.....29, 180
Fan A.....24, 179
Fanaselle W.....30, 87, 173
Faramarzi A.....27, 154
Farrow S.....27, 87
Faustman EM.....17, 19, 87, 99
Fazil A.....20, 23, 37, 151, 154
Feinleib M.....25, 121
Fernandez LE.....39, 88
Ferry JF.....26, 28, 88
Ferson S.....17, 32, 35, 89, 171
Fiebelkorn S.....22, 78
Figueiredo MS.....24, 143
Filipsson M.....24, 56
Finkel AM.....16, 20, 89
Finkel F.....16, 18
Finley BL.....18, 23, 39, 89, 107,
.....149, 170
Finster M.....31, 129
Fitzgerald M.....35, 148
Fitzpatrick JW.....22, 31, 90
Flari V.....16, 27, 90
Fleishman LA.....16, 91
Flores V.....23, 73
Foden W.....20, 104
Fong V.....31, 64
Forman S.....31, 123
Forshee RA.....34, 91, 192
Francis R.....26, 127
Frantzen K.....20
- Frederick RJ.....34, 91
Freudenburg WR.....36, 38, 92
Frey HC.....31, 69, 126
Friedman SM.....36, 92
Friedrichs S.....30, 156
Frith J.....17, 93
Fujikawa Y.....24, 93
Fujinaga A.....24, 93
Fuller C.....32, 142
Furgal C.....36, 83
Fuse M.....23, 131
- G**
- Gaborek BJ.....32, 93
Gaffney SH.....18, 160
Galbraith DA.....23, 39, 89, 107
Gallagher K.....22, 23, 90, 132
Gao HO.....16, 94
García S.....38, 94
Gardberg J.....32, 94, 142
Garvey PR.....20, 95
Gasparini L.....20, 98
Gauthier Y.....21, 95
Gentry PR.....19, 95
Georgopoulos PG.....35, 141
Gernand JM.....34, 95
Gerst MD.....38, 96
Giesecke R.....33, 96
Gift J.....19, 79, 196
Gilliland R.....29, 63
Gill V.....18, 182
Gilmore EA.....25
Gilmour L.....31, 97
Given LM.....20, 109
Glass D.....39, 164
Gochfeld M.....22, 23, 66
Goeden HM.....30, 98
Goldstein BD.....18, 97
Gonzalez C.....21, 84
Goodman JE.....22, 24, 101, 149
Gordon JG.....36, 104
Gordon S.....25, 109
Gormley AM.....20, 97
Goswami B.....30, 87
Graham S.....31, 157
- Gramling RB.....36, 92
Grayson D.....30, 156
Greco SL.....18, 98
Greene CW.....30, 98
Green JA.....18, 186
Gresh D.....20, 98
Grieger KD.....18, 99
Griffin PM.....18, 138
Griffith WC.....17, 19, 87, 99
Grimson R.....17, 89
Gröhn YT.....33, 153
Gruntfest E.....30, 180
Gruszczynski LA.....28, 99
Guidotti T.....33
Guidotti TL.....28, 100
Guikema SD.....26, 34, 122, 127, 142
Guimarães Pereira Â.....17, 100
Gunther AC.....37, 62
Guo Z.....28, 54, 100
Gurian PL.....32, 37, 107, 139
Gust LD.....30, 98
Gutierrez VV.....24, 101
Gwinn M.....30, 128
- H**
- Haas CH.....23, 175
Haas CN.....27, 37, 108, 177, 178
Habeggar L.....39, 88
Haber LT.....22, 29, 101, 118
Hagan NA.....23, 39, 101, 156
Haimes YY.....28, 54
Hakkinen P.....22, 119
Halabi S.....23, 101
Hald T.....17, 26, 33, 105, 106,
.....173, 175, 176
Hall IS.....35, 102
Hallman WK.....36, 102
Hamilton M.....35, 102
Hammack TS.....18, 182
Hammitt JK.....27, 156
Han JW.....37, 103
Hansen SF.....18, 99
Hanson BW.....34, 112
Hanson RD.....36, 103
Harper R.....23, 181
- Hart A.....27, 90
Harthorn BH.....36, 38, 59, 104, 161
Hartley AJ.....20, 104, 105
Hart PS.....20, 103
Hart S.....31
Hattis D.....35, 104
Hausken K.....26, 62
Havelaar AH.....26, 172
Haws LC.....23, 176
Haydarov R.....36, 104
Hayes B.....24, 84
Heard FJ.....37, 105
Heim K.....36, 124
Hemming DL.....20, 104, 105
Henning CC.....22, 169
Heres L.....26, 172
Herman KM.....18, 20, 74, 138
Hernandez MJ.....23, 73
Hill AA.....26, 33, 105, 106, 171,
.....173, 175
Hiraki T.....24, 93
Hoek A.....26, 172
Hoekstra RM.....20, 57, 74
Hoffman H.....34, 91
Hoffmann SA.....20, 107
Hoffman S.....20
Hollins DM.....18, 23, 107, 160
Hollnagel H.....18, 55
Hong T.....32, 107
Hooberman B.....30, 87
Haupt A.....36, 157
Howarth RB.....38, 96
Ho WC.....22, 106, 125, 145
Howe PD.....24, 107
Hsu HX.....24
Hsu-Kim H.....23, 101
Hsu X.....108
Huang A-T.....25, 109
Huang I.....19, 108
Huang Y.....27, 37, 108, 178
Hudson R.....29, 63
Hughes MF.....23, 55
Hwang MS.....24, 73

I

Ichida A.....38
 Imamura H.....27, 160
 Inoue K.....22, 115
 Ishibashi Y.....22, 185
 Ishikawa Y.....22, 115
 Isukapalli SS35, 141
 Ivanek R.....33, 153
 Iverson S.....22, 109

J

Jackson B23, 159
 Jackson M.....36, 124
 Jain M.....17, 176
 Jardine CG20, 109
 Jardine CJ.....36, 83
 Jaykus LA.....30, 110
 Jeitner C.....22, 66
 Jeong JS.....25, 71
 Jeong JY.....24, 73
 Jiang M.....24, 110
 Jiménez R.....24, 110
 John R.....17, 33, 111
 Johns D22, 112
 Johnson BB.....32, 112
 Johnson DR16, 160
 Jones DD.....34, 112
 Jones KL.....17, 71
 Jones L.....29, 113
 Joo IS25, 71
 Jordan W.....30, 134
 Judson R.....31, 75
 Julian-Reynier C.....35, 84
 Julias C.....22, 23, 38, 113, 119
 Jung KK.....24, 73

K

Kailiponi PK.....29, 31, 114
 Kaiser JP24, 114
 Kajihara H.....22, 115
 Kalinich J36, 115
 Kandlikar M.....36, 59
 Karvetski CW35, 115

Kause J38, 116
 Keenan JJ.....23, 36, 57, 187
 Keeney RL.....29, 116
 Keisler J.....19, 21, 69, 108, 126
 Keisler JM.....21, 35, 115, 194
 Keller C.....35, 116
 Kellon DS.....33, 36, 116
 Kelly D29, 180
 Kelly L.....26, 33, 105, 106, 173
 Kendall G39, 79
 Kiekintveld CD21, 151
 Kim HK.....23, 37, 103, 117
 Kim J.....36, 182
 Kirby R.....30, 117
 Kirchner SF.....23, 119
 Kishimoto A22, 115
 Kissel JC.....17, 38, 39, 71, 75, 118, 125
 Kizil GV.....24, 117
 Kleinmeier D18, 182
 Klockow KE.....24, 118
 Klonz K30, 87
 Knightly T22, 65
 Knutsen J38, 188
 Koch F193
 Kocian JL.....39, 118, 125
 Kohrman-Vincent MJ.....22, 118
 Koimtzoglou AN.....29, 183
 Kolasky BP.....29, 31, 60
 Kolasky RP.....29, 31, 97, 116
 Kolb Ayre K.....31, 121
 Kousky C.....38, 75
 Kovacs D22, 26, 119, 190
 Krabbenhoft D.....32, 142
 Krishen L.....24, 33, 119, 174
 Krogstad FTO.....17, 99
 Kronauge C.....23, 181
 Kroner O.....24, 84
 Krupka EA.....23, 119
 Kugihara N.....24, 120
 Kulka M30, 87
 Kundrot CE.....39, 54
 Kuttischreuter M.....27, 182
 Kuzma J28, 30, 120

L

Lambert JH. 28, 35, 38, 102, 115, 178
 Lamm SH25, 121
 Lander DR.....32, 121
 Landis WG31, 121
 Langstaff JL.....31, 157
 Lapinski M.....28, 64
 LaPuma PT22, 161
 LaRocca S34, 122
 Lathrop JF.....19, 21, 122, 157
 LaVail KH.....35, 122
 Lave LB.....25
 Lavelle KS.....22, 122
 Lavell J28, 126
 Le Brun M.....39, 185
 Le Coroller Soriano AG35, 84
 LeDuc SD.....34, 91
 Lee HM.....24, 73
 Lee KH.....24, 73
 Lee LK23, 123
 Lee R.....35, 148
 Lee RC.....31, 123
 Lee RM.....22, 169
 Legg MN.....26, 124
 Leiserowitz A21, 172
 Le MH.....18, 23, 123, 186, 187
 Lemus R.....36, 124
 Lester R.....22, 184
 Letinski DJ.....23, 194
 Levin EA.....39, 125
 Levine ES.....29, 39, 60, 116, 125
 Levitan L.....24, 163
 Levy JI38, 196
 Lewis RJ23, 194
 Liang X.....37, 62
 Li J.....39, 79
 Lin BL22, 115
 Linkov I.....16, 18, 19, 21, 23,
26, 35, 69, 99, 108, 115, 126,
166, 181, 190, 195
 Lin M.....22, 125
 Lin MH.....22, 106, 125, 145
 Lin YS.....22, 106
 Litovitz A.....16, 160

Liu C28, 126
 Liu X.....31, 69, 126
 Liu Y25, 127
 Liu Z26, 127
 Lizarazo JJ.....22, 38, 70, 127
 Lofstedt RE.....18, 21, 32, 64, 128
 Longhurst P.....37, 81
 Long MC.....32, 79
 Longstaff H35, 128
 Long TC.....22, 30, 112, 128
 Lopez-Jurado FB.....28, 129
 Louzis KA29, 183
 Loyce CL.....20, 150
 Luben T.....22, 112
 Luccioli S.....30, 87
 Lueck M30, 180
 Luft J32, 142
 Luis S38, 144
 Lu J25, 121
 Luke N22, 38, 113
 Lundell HC.....24, 129
 Luoma SN30, 129
 Lutz J21, 189
 Lynch M.....35, 104
 Lynne Haber29

M

MacDonell MM.29, 31, 39, 129, 191
 MacKenzie CA20, 130
 MacLean LC.....31, 130
 Maffre A.....33, 177
 Magee B34, 186
 Magnuson BA.....26, 130
 Maguire L.....30, 190
 Maier A.....22, 24, 84, 118
 Maier MA.....16, 53
 Makino R23, 131
 Makowski DM.....20, 23, 150
 Malavolti L.....35, 84
 Marcel F18, 137
 Marchant G20
 Marcum T.....22, 113
 Marenberg AA.....30, 181
 Markiewicz AJ.....31, 121
 Marks BP18, 131

Marlatt HL.....16, 30, 131, 180
 Martin LR.....23, 132
 Marty MS18, 55
 Masinter AM.....22, 132
 Maso C22, 65
 Mathers JJ33, 132
 Maule J.....27, 90
 Maynard AD28, 133
 McCammen I.....32
 McCarthy A.....34, 56
 McCoig A.....30, 87
 McColl S.....17, 192
 McComas KA...20, 36, 61, 103, 133
 McDonald M35, 128
 McDonald S27, 161
 McDowell RM.....23, 133, 167
 McEwen S23, 37, 151
 McGill WL.....24, 38, 39, 70,
110, 133, 174
 McKinley MA.....32, 147
 McLain JL.....30, 134
 McLaughlin CF.....28, 134
 McNeill D.....23, 134
 McNoldy B.....30, 180
 McVey ME30, 181
 McVey MM.....23, 32, 66, 135
 Mechtenberg AR.....16, 135
 Mednick A33, 135
 Meek ME.....21, 29, 34, 136
 Meneses V24, 137
 Menis M.....34, 185
 Mensah Y.....20, 137
 Merad M.....18, 19, 137, 138
 Meredith C.....22, 78
 Merrick J17, 145
 Meschke JS17, 39, 71, 118, 125
 Metcalf SW23, 194
 Mettee SL.....18, 138
 Miliotis M.....30, 87
 Miller CE.....36, 165
 Miller WD.....26, 138
 Mitchell A22, 138
 Mitchell-Blackwood J37, 139
 Mitrani-Reiser J.....26, 127
 Mohanty S.....24, 144

Mohapatra AK.....31, 139
 Mojdzuska E.....28, 139
 Mokhtari A28, 30, 64, 110, 140
 Money C.....22, 122
 Money ES.....16, 140
 Moolgavkar SH.....16, 140
 Morain MM.....37, 141
 Morgan MG16, 91
 Morisawa S27, 160
 Morrall J27, 85
 Morris JG.....20, 107
 Morris M.....23, 101
 Moyer D.....39, 141
 Moyer PF30, 98
 Mu D16, 166
 Mukherjee D35, 141
 Munkvold G.....34, 192
 Muñoz F22, 38, 70, 94, 127
 Murray-Tuite P29, 186
 Murr LE.....36, 165
 Musson-Genon L.....39, 185
 Muth MK.....30, 110

N

Naftz D32, 142
 Nakatsubo R24, 93
 Nakayachi K23, 142
 Nakayama A27, 160
 Narotsky MG.....22, 146
 Nataghi R.....34, 142
 Nauta M.....17, 176
 Neeley AD.....23, 133
 Neil KP18, 138, 182
 Nelson KC.....30, 78
 Neslo R.....16, 90
 Newsome R.....30, 110
 Nicolich MJ23, 194
 Niederdeppe J23, 32, 117
 Niles R.....30, 87
 Norman JE.....26, 180
 Nozick LK.....26, 124
 Nsofor O18, 182
 Nuckols J.....25, 109

O

Obasanjo O30, 87
 Öberg T.....24, 56
 O'Brien JP31, 143
 O'Donnell CM17, 83
 O'Fallon LR17, 83
 Ogilvie-Hendren C30, 128
 Oiso S18, 143
 Oliveira MD24, 143
 O'Lone RB23, 55, 194
 Onyen L22, 122
 Ordonez F17, 176
 O'Reilly E.....20, 98
 Orozco GA31, 144
 Ortiz DS.....16, 160
 Oryang D.....30, 87, 110, 173
 Osidele O24, 144
 Ott CM.....38, 144
 Ozkaynak H31

P

Pakiam J22, 119
 Pallapies D22, 122
 Palma-Oliveira JM... 23, 38, 144, 195
 Pana-Cryan R37, 105
 Pan SC22, 125
 Pan SH.....22, 106, 145
 Paoli G30, 110
 Pardus M36, 124
 Parish M18, 182
 Park B30, 156
 Parker A22, 118
 Parker FL.....145
 Park SH25, 71
 Parmar R33, 135
 Parnell GS.....17, 145
 Parvez S22, 146
 Patterson J.....16, 25, 53, 146
 Paustenbach DJ ..18, 31, 36, 57, 123,
146, 160, 182
 Pavlova Y29, 147
 Payno Morant M37, 147
 Peek L30, 180
 Peeler E37, 147

Pelot R20, 189
 Penman M32, 57
 Perez AL32, 147
 Perona R34, 35, 148, 159
 Perrin F17, 148
 Perry WG.....18, 148
 Perschon C32, 142
 Peshlov BN31, 39, 129, 191
 Peters E33, 67
 Peterson D.....39, 88
 Peterson MK.....24, 149
 Phelka AD18, 149
 Philbrick M.....24, 149
 Philibert AP.....20, 23, 150
 Picut CA.....36, 157
 Pidgeon N..16, 38, 75, 104, 150, 161
 Pielat A26, 172
 Pinelli JP26, 127
 Pinnix A29, 160
 Pinsent C.....23, 159
 Pintar KDM.....23, 37, 151
 Pinto A12, 26
 Pinto CA20, 137
 Pita GL.....26, 127
 Pita JA.....17, 21, 151, 176
 Pittfield T22, 66
 Pitt J18, 55
 Plewa MJ39, 171
 Pollard S37, 81
 Pollard SJT.....20, 30, 33, 37,
39, 79, 97, 147, 153, 156
 Pollari FP23, 37, 151
 Poortinga W16, 150
 Post K.....37, 152
 Pottenger L18, 55
 Powall M28
 Powell M28, 152
 Powers C23, 66
 Pradhan AK33, 153
 Preston RJ.....16, 53
 Preuss P31, 75
 Price PS.....23, 55
 Priem P22, 122
 Prpich G.....33, 37, 147, 153

Prueitt RL22, 101
 Purdie AJ.....29, 60

Q

Quiring SM.....34, 142

R

Rachman NJ.....26, 153
 Rachman NR28, 153
 Rak A27, 154
 Ramirez DA36, 165
 Rao PSC.....16, 166
 Ravel A20, 154
 Reckhow KH16, 140
 Reed DA34, 154
 Reimann-Garretson L.....24, 162
 Reiss R31
 Reniers G29, 147
 Renn O21, 155
 Rice GE.....22, 39, 146,171
 Richards M31, 123
 Richardson MJ26, 155
 Richman A.....31, 130
 Richter D23, 101
 Rickard LN31, 155
 Ridley CE.....34, 91
 Riederer AM.....18, 98
 Rivera-Núñez Z.....25, 191
 Rivers L26, 37
 Rix G24, 162
 Robbins S25, 121
 Roberts MC.....39, 125
 Robins N23, 101
 Robins NA.....39, 156
 Robinson LA.....12, 27, 32, 156
 Robison SH23, 55
 Robotham KO.....39, 54
 Rocks S33, 37, 153
 Rocks SA.....20, 30, 37, 39,
79, 97, 147, 156
 Rokneddin K.....34, 157
 Rose A33, 96
 Rosenbaum AS.....31, 157
 Rosoff H.....17, 33, 111

Ross B.....21
 Ross M.....30, 98
 Ross RG19, 21, 122, 157
 Roszell LE36, 157, 165
 Rouse JF.....35, 158
 Rowell A.....36, 158
 Rowlands JC.....16, 53
 Royce F.....16
 Rush-Sirski A37, 158
 Rushton L.....39, 164
 Ruzante JM.....20, 154
 Ryker SJ17, 83
 Ryti RT34, 159

S

Safi A26, 159
 Safruk AM.....23, 159
 Sager SL29, 160
 Saghir S18, 55
 Sahmel J18, 23, 38, 107, 160, 188
 Samaras C16, 160
 Sampson AR.....39, 177
 Sanaa M.....17, 33, 148, 177
 Santos JR.....20, 52
 Sapio F.....193
 Sasaki K.....27, 160
 Satterfield T36, 38, 59, 104, 161
 Scanlon KA27, 161
 Scanlon KS.....22, 161
 Schaffner DW17, 162
 Scharff RL.....20, 162
 Scharks T24, 29, 63, 162
 Schaub J.....28, 139
 Scherer CW24, 31, 32, 155, 163
 Scheufele DA16, 35, 36, 37, 62,
67, 68, 102
 Schlag AK.....28, 163
 Schlosser P21
 Schlosser PM.....21, 163
 Schnatter AR..22, 23, 39, 55, 122, 164
 Schnatter R39
 Schoeny R.....29, 164
 Schubert W.....30, 180
 Schuetz H27, 63
 Schulte PA.....18, 164

| | | | | | | | |
|-----------------------|------------------------------------|------------------------|--|-------------------------|-----------------------|----------------------------|------------------|
| Schultz MT..... | 21, 165 | Smith Jr. W..... | 26, 159 | Tetsuji N..... | 24, 178 | Wu K-Y..... | 22, 35, 72, 125 |
| Schuster BE..... | 36, 165 | Smith M..... | 30, 173 | Teuschler LK..... | 22, 39, 146, 171 | Wu TN..... | 22, 125 |
| Schütz H..... | 27, 182 | Smith N..... | 21, 172 | Thakali S..... | 22, 101 | Y | |
| Schweizer V..... | 36, 165 | Snary EL..... | 17, 26, 33, 37, 81, 105, 106, 171, 173, 176 | Thedéen T..... | 24, 178 | Yamamoto K..... | 22, 185 |
| Scofield M..... | 31, 129 | Soane E..... | 39, 79 | Thekdi SA..... | 38, 178 | Yamazaki M..... | 23, 131 |
| Scofield R..... | 36 | Socero V..... | 38, 144 | Thompson KM..... | 17, 179 | Yang C..... | 34, 56 |
| Scott L.L.F..... | 39, 89 | Sofge CW..... | 18, 164 | Thorne S..... | 22, 26, 119, 190 | Yang H..... | 34, 192 |
| Scott PK..... | 23, 31, 182, 187 | Sohn YW..... | 25, 71 | Thran B..... | 38, 179 | Yang J..... | 20, 37, 52 |
| Scouras J..... | 36, 166 | Soller JA..... | 38, 173 | Thrush M..... | 37, 147 | Yang ZJ..... | 36, 192 |
| Seager TP..... | 16, 21, 35, 69, 166 | Solyst JM..... | 36, 174 | Thuett KA..... | 23, 32, 147, 170, 187 | Yaroschak PJ..... | 27, 193 |
| Seagert T..... | 29 | Sorensen AD..... | 38, 174 | Ting D..... | 24, 179 | Yatsalo B..... | 22, 184 |
| Selin C..... | 17, 166 | Spaccasassi C..... | 20, 98 | Tisch JS..... | 29, 180 | Yemelyanov AA..... | 31, 193 |
| Seno-Alday S..... | 36, 167 | Sparrevik M..... | 28, 174 | Tocalino PL..... | 26, 180 | Yemelyanov AM..... | 31, 193 |
| Seo K..... | 20, 167 | Spence A..... | 16, 150 | Todd E..... | 28, 64 | Yemshanov D..... | 193 |
| Sequeira RA..... | 23, 167 | Spencer J..... | 38, 188 | Toll JE..... | 21, 165 | Yoneda M..... | 27, 160 |
| Seto EYW..... | 26, 168 | Stedman R..... | 20, 103 | Toman E..... | 30, 190 | Yoon HS..... | 25, 71 |
| Severtson DJ..... | 23, 26, 168 | Steinhardt J..... | 22, 174 | Toshinari S..... | 24, 178 | Yuan C..... | 24, 163 |
| Shan X..... | 24, 169 | Stelljes M..... | 22, 57 | Toton E..... | 36, 166 | Z | |
| Shao K..... | 27, 169 | Sterling D..... | 24, 174 | Travis KZ..... | 22, 122 | Zabinsky Z..... | 34, 154 |
| Shapiro AJ..... | 22, 32, 66, 169 | Stinson JM..... | 31, 121 | Trumbo C..... | 23, 30, 180, 181 | Zan H..... | 20, 162 |
| Shapiro S..... | 16, 169 | Streetman SS..... | 21, 175 | Trumbo CW..... | 16, 131 | Zan K..... | 21, 126, 194 |
| Shatkin JA..... | 26, 170 | Stuart AL..... | 24, 85 | Trump B..... | 21, 35, 126, 181 | Zarayskaya IM..... | 24, 194 |
| Shaw BR..... | 16, 28, 35, 67, 68, 78 | Subbiah J..... | 34, 112 | Tsai J..... | 17, 176 | Zdanowicz R..... | 33, 135 |
| Shaw DM..... | 34, 91 | Sullivan D..... | 36, 124 | Turley AT..... | 30, 32, 66, 181 | Zeise L..... | 34, 194 |
| Shaw RHAD..... | 21, 95 | Su-Miao L..... | 39, 125 | Turner MM..... | 30, 36, 117, 182 | Zelenka MP..... | 23, 194 |
| Shay E..... | 23, 170 | Sunger NE..... | 23, 175 | U | | Zelinka M..... | 30, 77 |
| Shay EC..... | 23, 187 | Sutcliffe H..... | 30, 156 | Unice KM..... | 31, 36, 57, 182 | Zemba SG..... | 22, 23, 184, 195 |
| Shipp SS..... | 17, 83 | Swain GM..... | 22, 122 | V | | Zepp R..... | 33, 135 |
| Shirai JH..... | 38, 39, 75, 118 | Swart A..... | 26, 33, 105, 106, 171, 172 | Valberg PA..... | 24, 149 | Zerbe R..... | 27 |
| Shubat PJ..... | 30, 98 | Swart AN..... | 17, 26, 173, 175, 176 | Vandenberg J..... | 23, 101 | Zerbe RO..... | 27, 32, 79, 81 |
| Shukla S..... | 22, 66 | Syal S..... | 21, 189 | Van Doren JM..... | 18, 182 | Zhao F..... | 16, 166 |
| Siaw - Asamoah D..... | 17, 170 | T | | van Wingerden AM..... | 27, 182 | Zhao J..... | 19, 196 |
| Siegrist J..... | 17, 35, 89, 171 | Tabuchi E..... | 20, 167 | Vedomoske MA..... | 28, 183 | Zhongwei L..... | 26, 159 |
| Siegrist M..... | 29, 170 | Tachovsky JA..... | 23, 176 | Venables D..... | 16, 150 | Zhou T..... | 30, 87 |
| Sigal EA..... | 23, 159 | Tambe M..... | 17, 21, 151, 176 | Ventikos NP..... | 29, 183 | Zhuang J..... | 24, 25, 111, 169 |
| Silva L..... | 25, 109 | Tamrakar SB..... | 37, 177, 178 | Vigoren EM..... | 17, 99 | Ziegler D..... | 33, 135 |
| Simmons JE..... | 22, 39, 146, 171 | Tanaka Y..... | 39, 177 | Vigre H..... | 26, 173 | Zielinski-Gutiérrez E..... | 23, 181 |
| Simmons M..... | 27, 154 | Tang G..... | 39, 164 | Viscusi WK..... | 27, 87 | Ziobro GC..... | 18, 182 |
| Simonetti A..... | 34, 185 | Tauxe J..... | 35, 148 | Vogel CM..... | 27, 154 | Zwack LM..... | 38, 196 |
| Simons RRL..... | 26, 33, 105, 106, 171, 173, 175 | Tear L..... | 21, 165 | Volpe R..... | 30, 184 | | |
| Skubisz C..... | 36, 182 | Tenenhaus-Aziza F..... | 33, 177 | von Stackelberg KE..... | 18, 22, 184, 188 | | |
| Slovic P..... | 19, 33, 67, 172 | Tennant J..... | 26, 173 | Vrijhof H..... | 22, 122 | | |
| Small M..... | 27, 169 | Teske SS..... | 37, 178 | | | | |
| Smid JH..... | 26, 172 | | | | | | |

NOTES

NOTES

NOTES

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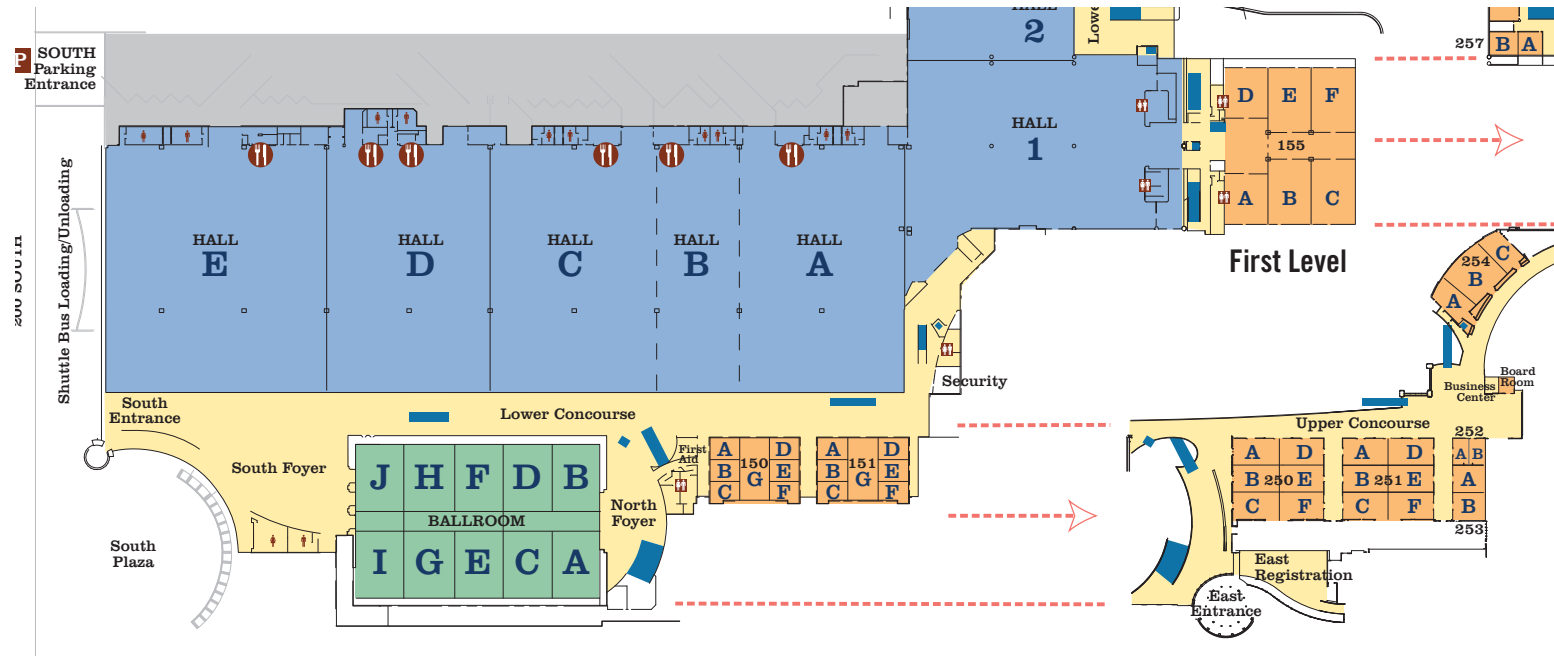


First Floor Marriott



Second Floor Marriott

Salt Palace Convention Center Floorplan



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