T3-C.3 Öberg, T; European Chemicals Agency; tomas.g.oberg@gmail.com

Substitution of Chemicals in the European Union based on Assessment of Hazard, Risk and Impact

The chemicals policy in the European Union aims at ensuring a high level of protection of human health and the environment both for present and future generations while also ensuring the efficient functioning of the internal market and the competitiveness of the European chemical industry. Substitution of dangerous substances by safer alternatives or technologies has then become an important policy objective and is a key element in the REACH regulation. Sometimes the objective to substitute dangerous substances has been identified as being solely based on hazard assessment, not considering the need for risk and impact assessments. However, even if hazard is the driver for substitution, no decisions under REACH on restriction proposals (bans) or applications for authorisation are made without proper risk assessment and if needed socio-economic analysis (SEA). The assessment of impacts through SEA considers health and environmental benefits, the associated costs and other socio-economic impacts. Recent cases handled by the Scientific Committees of the European Chemicals Agency will be used to illustrate how these assessments interplay in the restriction and authorisation processes of REACH. A further challenge to the assessment of risk and socio-economic impacts stems from substances that are characterised by hazard properties as being persistent, bioaccumulating and toxic (PBT) or very persistent and very bioaccumulating (vPvB). Progress in developing a framework for socio-economic analysis of these PBT/vPvB substances will also be discussed.

W3-I.4 Abadin, HG*; Wheeler, JS; Agency for Toxic Substances and Disease Registry; hgala@cdc.gov

Occupational Health Data for Environmental Exposure Decisions

ATSDR has been mandated to develop significant human exposure levels for hazardous substances. Also, to make public health decisions regarding environmental exposure of populations to these hazardous substances. Health guidance values provide the basis for making these decisions and these have taken the form of minimal risk levels (MRLs). Development of any health-based value is limited by the availability of sufficient and reliable data to identify the most sensitive target organs. The “ideal” data set comes from toxicity studies of similar populations in similar exposure scenarios to that for which the guidance value is being derived. Unfortunately this type of data is often not available so the environmental health scientist must look outside the “ideal” data set and examine data from other sources such as occupational studies. Although there are important differences between worker populations and the general public, data derived from occupational studies are important for gaining an understanding of health impacts from chemical exposures and for developing acceptable levels of exposure that will be protective for exposed populations. This presentation discusses substances for which ATSDR has utilized occupational data to derive MRLs for individuals and communities being exposed in non-occupational settings.

P.94 Abedinioohi, F*; Baecher, G.B.; University of Maryland; gbaecher@umd.edu

Societal risk criteria and risk aversion

Tolerable risk criteria as frequency-number (F:N) charts have become popular in natural hazard sectors, for example, in relation to large civil infrastructure. These are sometimes called societal risk criteria in that they set a threshold of tolerable annual exceedance probability (AEP) as a function of the number of lives lost. Many in the engineering community find societal risk criteria appealing because the criteria function essentially as standards, removing the burden of difficult trade-offs. This paper concerns the framework in which such judgments of tolerable risk are made, and the relation of societal risk criteria to risk aversion in the sense of classical utility theory. First, the history of societal risk criteria is summarized, from Ian Farmer to present applications in representative countries (NL, UK, AUS, US). Then the relationship of risk aversion to current uses of F:N criteria is explored. The present approach to F:N curves is to represent tolerable risk criteria as lines of negative slope in log-log space. Typically, the criterion is fixed by an anchor point and an associated slope. Authorities in the UK, US, and AUS tend to slopes of -1, but the Dutch have standardized -2. The slope of the line is commonly argued to relate to the degree of aversion to multiple fatalities. Historically, there has been a sense that a slope of -1 is risk-neutral, but this is not the case. Noting that F:N curves cannot easily be compared with one another for the purpose of judging which curve represents the higher overall societal risk, it is proposed that the underlying utility function might be better used to calculate “social cost.” It is argued that appropriate F:N criteria imposing risk aversion do not have to be straight lines or to have slopes of less than -1. The relationship of F:N curves to the derivative f:N curves is explored as an easier mathematical basis for risk aversion comparisons.

W2-B.2 Abelkop, A*; Graham, J; Indiana University; abelkop@indiana.edu

Regulation of Chemical Risks: Lessons for TSCA Reform from Canada and the European Union

The United States Congress is considering proposals to reform the Toxic Substances Control Act (TSCA) of 1976. This Article compares recent reforms in Europe and Canada in order to draw lessons for TSCA reform. In 2006, the European Union enacted the Registration, Evaluation, Authorization, and Restriction of Chemicals (REACH) program while Canada used existing authority under the Canadian Environmental Protection Act (CEPA) of 1999 to initiate the 2006 Chemicals Management Plan (CMP). Focusing on the tens of thousands of industrial chemicals now in use in the USA, we offer two suggestions for TSCA reform based on the European and Canadian experiences: (1) Congress should consider applying the Canadian approach to prioritization, where high-priority chemicals were identified for assessment and regulation based on limited data and modeling/screening exercises, and (2) Congress should consider applying the European approach to chemical registration for high-priority substances where the burden of generating data and proving safety of specific uses is placed on industry. In summary, an industry obligation to register high-priority chemicals and defend the safety of specific uses would bring new life to TSCA.
M2-F.4 Adgate, JL*; Bourgeron, PB; University of Colorado; john.adgate@ucdenver.edu

Linking Ecosystem Services and Health Risk Assessment to Address Sustainability

As part of a NSF funded Sustainability Research Network grant exploring “Routes to Sustainability for Natural Gas Development and Water and Air Resources in the Rocky Mountain Region” (airwatergas.org) we are conducting a cumulative risk assessment to evaluate the range of hazards present over the decades-long period of oil and gas well development, production, maintenance and eventual reclamation. This presentation discusses methods we are developing to evaluate cumulative risks to public health from chemical and non-chemical stressors associated with unconventional petroleum development in and around communities. The major potential stressors existing in and around these sites include air pollution, ground and surface water contamination, a range of physical stressors (e.g., truck traffic, noise pollution), accidents and malfunctions and psychosocial stress associated with community change. We evaluate these stressors, the spatial scale of their impacts and discuss the methodological limitations of current CRA approaches, particularly the challenge of addressing multiple trade offs that confront decision-makers. We also present the results of an analysis of public health impacts as they relate to ecosystem services as represented by a socio-ecological systems (SES) modeling approach. A case study is used to illustrate these methods, evaluate uncertainties and compare results of SES modeling with existing approaches to assess cumulative risk.

M4-I.2 Altemose, BA; SafeBridge Consultants, Inc.; brent.altemose@safebridge.com

Application of Hazard and Control Banding Concepts and Risk Matrices to Prospective and Retrospective Chemical Risk Assessments

In the absence of strong quantitative data for chemical exposures or toxicological risk, hazard and control banding concepts are applied to estimate relative exposure risk. Furthermore, using exposure and toxicological risk estimates, risk matrices are applied to estimate of the risk of health effects from the chemical exposures in question. The risk matrices used are based on a modification of traditional risk matrices, and apply measures of exposure frequency and health effect severity on a logarithmic scale. The output is used to risk rank exposed populations and may be applied either prospectively or retrospectively to a broader chemical risk assessment.

T2-C.1 Alderson, DA*; Carlyle, WM; Ross, JD; Naval Postgraduate School; dlalders@nps.edu

Assessing and Improving Resilience of Infrastructures to both “Worst Case” and “Most Likely” Events

Recent events have shown our critical infrastructure systems to be vulnerable to both non-deliberate hazards (e.g., extreme weather, technological failure) and deliberate threats (e.g., terrorist attacks). These events often point to different parts of an infrastructure system as critical, leaving policy makers in a quandary about how to invest a limited budget to increase system resilience. Using a historical example, we contrast and reconcile these views under a common risk-based perspective.

P.47 Anderson, D; Davidson, RA*; Himoto, K; Scawthorn, C; University of Delaware; rdavidso@udel.edu

New statistical approaches to modeling post-earthquake fire risk using data from the Tohoku, Japan earthquake and tsunami

The Tohoku, Japan earthquake and tsunami caused 348 reported fires—more than any other earthquake in history. By comparison, there were about 110 recorded in Kobe (1995), 110 in Northridge (1994), 128 in San Fernando (1971), and 36 in Loma Prieta (1989). The Tohoku fires occurred in a variety of land area types from urban to rural, and were caused by two distinct hazards—ground motion and tsunami inundation. As they were all part of a single event, the dataset describing the fires could be collected at one time ensuring a consistency not possible when compiling data from multiple events over many years. Because of the size and features of the fire dataset it generated, this event offers a unique opportunity to improve the statistical models of post-earthquake ignitions that rely on such data and that are critical for planning for the emergency response needs and total losses that can result from such fires. Using a new dataset compiled for the Tohoku event, this paper offers both methodological and application-oriented contributions. First, we compare three promising model types—generalized linear models (GLMs), generalized additive models ( GAMs) and boosted regression trees (BRTs). The latter two have not been used in this application previously. In the process, we also improve estimation of each model’s predictive power compared to previous efforts, i.e., how well it will predict the number and locations of ignitions in a future earthquake and how much and what type of errors to expect. Second, we introduce and compare new models for ground motion-generated and tsunami-generated post-earthquake ignitions in Japan. To our knowledge, no such model for tsunami-generated ignitions exists for any region.
**P.97 Anderson, AA; Colorado State University; ashley.a.anderson@colostate.edu**

**Floods, communication, and climate change: Examining social media posts about climate change during the 2013 Colorado floods**

A growing body of scholarship is investigating how extreme weather events shape how people perceive climate change (e.g., Birk, Carvalho, & Jones, 2012; Truelove, & Duell, 2010; Leiserowitz, Maibach, Roser-Renouf, Feinberg, & Howe, 2013). These weather events are tangible and local experiences that make climate change more personal rather than an abstract and distant concept (Spence, Poortinga, & Pidgeon, 2012). Research has yet to fully investigate how different communication sources, including television and newspaper news, discussions with friends and relatives, and social media usage, play a role in how people interpret climate change through the lens of an extreme weather event. Yet, these communication sources play an integral role in how people relate experiences with one extreme weather event, the state-wide floods in Colorado in 2013, to perceptions about climate change. General discussion about climate change is low, with the majority of Americans reporting they rarely or never talk about the issue with their friends or family (Maibach, Roser-Renouf, & Leiserowitz, 2009). Nevertheless, the flooding event was highly discussed by people in Colorado. Indeed, research shows that the majority of people in the United States (89%) have talked with other people about an extreme weather event at least once (Leiserowitz, Maibach, et al., 2013). In this study, I use a content analysis of all Twitter discussions (n = 4,085) mentioning the floods and climate change to understand how individuals discuss climate change in the context of an extreme weather event.

**M4-H.2 Anitole, K; Aylward, L; Lorber, M*; Blake-Hedges, L; Brewer, B; Olsen, M; U.S. EPA; anitole.katherine@epa.gov**

**Phthalates Case Study**

There is a relatively rich database of information on phthalates available through biomonitoring data that provides information on internal dose. As a result, there is greater certainty about the magnitude of biologically relevant exposures for selected phthalates than for many other chemicals. These data have been used to conduct population-level cumulative risk assessments for a subset of phthalate compounds. However, these assessment alone does not allow identification of the most important sources and pathways of exposure relevant to specific uses that can be regulated under the Toxic Substances Control Act (TSCA). Additional information is required to effectively target alterations or interdictions of exposure for a particular TSCA use or subset of uses. Phthalate compounds are used in a wide range of applications and products; a specific compound’s use depends on its distinctive physical and chemical properties. Presence of phthalate metabolites in urine (as measured in NHANES) prove the ubiquitous exposure to multiple phthalates. Exposure can occur through direct contact with products containing phthalates, or through indirect pathways and matrices including air, water, soil, dust, and food. For many phthalates, food is the primary exposure pathway, with food processing and packaging cited as the primary cause for entry of phthalates into food. The case study will provide recommendations on approaches to an exposure assessment that will help EPA more fully understand the issues involved with conducting a CRA on chemical classes with complex temporal and exposure circumstances. The case study will also develop a set of questions, such as areas of uncertainty and data gaps, to guide future work in complex multi-chemical class assessments at the agency.

**W4-K.1 Andrijcic, E; Rose-Hulman Institute of Technology; andrijcic@rose-hulman.edu**

**The Survey of Best Practices in Risk Education: An Overview**

The need for future scientists, engineers, and business managers who can effectively design and manage complex systems is becoming more critical. In order to develop the skills necessary to succeed in a risk-laden environment, a wide range of undergraduate and graduate students in varied disciplines ought to be introduced to general risk-related concepts that will enable them to better envision possible future changes and to effectively respond to risks in a timely manner. Accordingly, this presentation concerns itself with identifying the best practices in risk education that can be utilized to deliver general risk-related content to students in various academic disciplines. There currently does not exist a set of best practices in risk education, resulting in discipline-specific risk content being delivered to a limited number of students. We argue that despite the divergent nature of advances that have been made in the area of risk assessment, management and communication, it is possible to identify a set of general and interdisciplinary risk-related concepts that can be presented in a streamlined, widely-accessible and quality-controlled manner. We present a summary of a survey on best practices in risk education which was conducted among a group of academics and practitioners. The specific topics include the identification of general and non-discipline specific risk assessment, management and communication concepts that academics have been teaching in their classes, and that practitioners deem important for success in the workplace; specific classroom learning objectives and innovative teaching methods currently used to deliver risk-related concepts to students; relevant materials that support those learning objectives; and an assessment of whether the risk-related concepts and skills that are currently being taught are in line with the concepts and skills that industry practitioners deem necessary for dealing with risk outside of academic circles.

**T3-J.5 Aoyagi, Midori; National Institute for Environmental Studies; aoyagi@ines.go.jp**

**Determinants of food purchasing behavior and risk perception**

After the nuclear power plants’ accidents in March 2011, farmers in Fukushima and the surrounding area have been suffering from the radioactive contamination of their products. Even after farmers’ made great efforts to produce safe foods in those three years, they have been suffering the rumors of radioactive contamination of their products. We carried out a public opinion survey in February 2013, almost two years after the accidents, and analyzed the determinant of food purchasing behavior. According to our surveys, people did not satisfied with scientific evidence of health risk, but this is not an effective way for relieving people.
T2-H.2 Arcella, D; European Food Safety Authority; jannavi.srinivasan@fda.hhs.gov

International exposure assessment based on national survey: good practices and limits

The accuracy of any international exposure assessment will ultimately depend on the precision in the two calculation inputs – chemical concentration and food consumption. In order to be protective of public health at an international level, multi-national calculations should provide exposure estimates that are equal to or greater than the highest exposure observed at the national level. Food consumption and chemical concentration data are therefore required, as far as possible, for each country. Chemical concentration data from different countries are often pooled to derive international representative concentrations for use in multi-national dietary exposure calculations. By doing this it is assumed that it is a global market and concentrations from commodities sampled in one country are representative of the others.

P.3 Arimoto, CW*; Howard, PM; Lepofsky, M; Randolph, MA; ABS Consulting Inc.; carimoto@absconsulting.com

Fast-running Chemical Dispersion Model Development for the Non-Scientist to Support Risk Analysis

The release of a toxic, explosive, or flammable chemical from a storage container, initiated by either adversarial actions or safety hazards, could result in environmental and economic consequences that are considerable. ABS Consulting supports the Department of Homeland Security and the United States Coast Guard in assessing the risk of chemical releases from industrial facilities, vessels, barges, and railcars.

These risk assessments aid in the development of policies, regulations, and strategies which aim to mitigate the risk of releases and protect the public. The timely evaluation of risk requires simplified tools that can estimate the consequences of an event in a timely and consistent manner for analysts without a specific scientific background. ABS Consulting has developed a unique tool for analyzing the risk of chemical releases, the Certain Dangerous Cargo (CDC) Consequence Calculator. The CDC Calculator is a fast-running Geospatial Information System-based (GIS) chemical dispersion modeling tool available within the USCG’s Enterprise-GIS system. The calculator applies the Second-order Closure Integrated Puff (SCIPUFF) model in a server environment to translate time-based concentrations at defined sensor locations into fatality estimates using probit functions. ABS uses geospatial processing to determine location-specific population results for an analyzed chemical release. For each release, to which it applies, it assigns fatality percentage zones to determine an estimated fatality count. Release events can be triggered by accidental or intentional events and simulated in either a specific location or anywhere along the route of a transiting chemical inventory (such as along a planned vessel, barge or train path). In addition to supporting risk analysis, the visual nature of this geospatial tool makes it an effective risk communication tool as well.

P.1 Armstrong, TW; TWA8HR Occupational Hygiene Consulting, LLC; twa8hr@gmail.com

Evaluation of Retrospective Exposure Assessment Validity: Stochastic Analysis Estimates of Sensitivity and Specificity from Inter-Rater Kappas and Exposure Prevalence

Retrospective exposure assessments (REA) for epidemiological studies may rely on expert opinion based methods. Within the REA and expert opinion realm, many different approaches have been used, depending on study goals and the availability of information such as work histories and relevant measured exposure data. We report an exploratory assessment of a set of exposure ratings from three expert based evaluations of the same group. The full study set of five point semi-quantitative ordinal scale EAs was developed by an experienced team that drew on work history, published literature, some work-site visits, limited modeling, limited task simulations, and available short term area measurements. The comparative sets by raters B and C drew only on work history information and the experts' knowledge. Weighted kappas were calculated, with results suggesting moderate agreement (Ks 0.5 to 0.54). These were then reduced to a dichotomous exposed, unexposed base for the analysis of the possible sensitivity and specificity. Kappa values for the exposed/unexposed inter-rater agreements were lower, at 0.34 to 0.5. The kappas and estimated prevalence of exposure were then used to estimate possible values of the study EA sensitivity and specificity. The study had relatively low exposure prevalence, and kappas for the validation study were in the range of moderate agreement. The stochastic analysis results suggest the median values for sensitivity and specificity were 0.82 and 0.95 respectively. The analysis also illustrates the possible effect on sensitivity and specificity of improved EA as indicated by improved Kappa values, such as by further collaboration or improved data. The analyses also include examination on the influence of exposure prevalence on sensitivity and specificity.

P.2 Arnold, SF*; Ramachandran, G; Stenzel, M; Drolet, D; University of Minnesota, Division of Environmental Health Science; arnold353@umn.edu

Improving Qualitative Exposure Judgment Accuracy in Retrospective Exposure Assessment

Retrospective exposure assessment relies heavily on the exposure assessor’s professional judgment to draw conclusions about the exposure from incomplete data sets. Professional judgment is guided by many inputs; some are subjective, e.g. ‘mental models’ and some are objective. How accurate are these conclusions, and do the inputs to decision making, and the way in which they are incorporated into the assessment, influence exposure judgment accuracy? Qualitative exposure judgment accuracy, based on subjective inputs is low (mean ~ 30%), motivating the development of a new tool, “The Checkliset”, providing objective input to professional judgment. Comprised of 3 heuristics, it is based on physical chemical principles and was refined empirically, through experience. The Checkliset provides an ordered approach for applying these principles, and is applicable to volatile and semi-volatile vapor, fiber, aerosol and particulate exposure scenarios. Requiring only four pieces of information: the OEL, vapor pressure of the pure chemical (for vapors), the observed workplace control measures and the ‘required level of control’, the tool is easy to use and is freely available from the AIHA Exposure Assessment Strategies Committee. This influence of this tool on qualitative exposure judgment accuracy was evaluated in a series of workshops in which participants evaluated exposure scenarios, in the absence of personal exposure measurements. Judgments guided by the Checkliset were significantly more accurate, ~60% categorical accuracy, based on the AIHA Exposure Assessment Strategy, and ~70% accurate or overestimating by one exposure control category. The workshop results strongly support the use of this objective tool over other subjective inputs to professional judgment. These results are especially encouraging for retrospective exposure assessments, where data gaps are a constant challenge. Checklist-based judgments can be used to develop informed Bayesian priors, increasing the power of small data sets, producing highly confident, accurate posteriors.
**W2-B.3 Ashley, EM; Office of Management and Budget; eashley@omb.eop.gov**

**The Timing of Health and Longevity Impacts Associated with Exposure to Coal Mine Dust**

Health and safety regulations are often informed by multiple analyses, conducted with different methods and for different purposes. For instance, a regulation’s accompanying risk assessment may quantify the likely reduction in morbidity or mortality, as of a certain age, associated with a change in cumulative exposure to a chemical, biological or other hazard. Meanwhile, for the appropriate application of discount rates, the regulation’s cost-benefit analysis requires not just estimates for a particular age but a fuller depiction of the timing of impacts. If the results of the risk assessment are used as inputs to the cost-benefit analysis, then it becomes necessary to make assumptions about the pattern in time of exposure-related health and longevity effects. The goal with this analysis is to examine whether such assumptions can be improved, in the illustrative case of coal mine dust exposure. To that end, I consider evidence on coal miner mortality with previously-used assumptions about the timing of adverse health and longevity impacts attributable to occupational exposure to respirable coal mine dust.

**M3-B.1 Aven, T; University of Stavanger, Norway; terje.aven@uis.no**

**A new SRA glossary for risk terminology**

In this talk a draft of a new Society of Risk Analysis (SRA) glossary for key risk terms will be presented. The draft has been developed through a thorough process organized by the Specialty Group (SG) on Foundational issues in Risk analysis (FRASG). The glossary covers terminology on basic concepts (such as risk, hazard, vulnerability, uncertainty, knowledge), terminology on related concepts, methods and procedures (such as risk assessment, risk appetite, risk perception and model uncertainty), and terminology on risk management actions (such as risk tolerance, risk acceptance, risk policy and risk regulation). For key concepts such as risk - the glossary is based on different perspectives, allowing for a dichotomy between a broad qualitative definition of the concept and different ways of measuring it. In this way broad consensus has been established in the glossary committee and hopefully can also be achieved in the broader risk analysis community.

**W1-F.5 Augusto, S.; Pinho, P.; Santos, A.; Botelho, M.; Palma-Oliveira, J.*; Branquinho, C.; Universidade de Lisboa; jpalma-oliveira@fp.ul.pt**

**Biomonitoring as a tool for Risk Analysis for industrial emissions: the case of cement production**

Lichens, symbioses between fungi and algae, have been used to estimate human exposure to persistent organic pollutants (POPs) at a spatial scale. The fact that lichens are long-lived organisms, with a remarkable ability to bioaccumulate atmospheric pollutants over time, together with their wide geographical distribution, contributes to their success in environmental health studies. Time integration of pollutants by lichens allows correlating low levels of pollutants with chronic effects on human health; whilst their wide distribution allows collecting them from a number of sites using low resources and obtaining information of environmental levels of pollutants with a high spatial resolution. In this study we’ll show an industrial case-study where lichens have been integrated into an environmental monitoring plan aiming to assess environmental impact and human health risk of PCDD/Fs in the vicinity of a cement manufacturing plant with co-incineration of alternative fuel. For that, dioxins and furans (PCDD/Fs) were analyzed in lichens and soil collected over 5 years in the vicinity and surrounding area of the cement plant. Data from lichens were compared with data from an environmental baseline study performed 10 years ago, using the same lichen species as biomonitor in the same region. Results showed that PCDD/F concentrations in lichens have decreased from 2000 to 2011 in the study area, following the declining trend that has been observed worldwide for other matrices. Data from both lichens and soils were used to select areas with highest and lowest risk of human exposure to environmental PCDD/Fs. It will be discussed the integration between the lichens data and the output of the QRA in the same site.

**T3-I.1 Aven, T; University of Stavanger, Norway; terje.aven@uis.no**

**Some reflections on uncertainty treatment in risk analysis**

In this talk the uncertainty issue in risk assessment and management contexts is revisited. A new type of uncertainty structure is presented and discussed. It is based on a distinction between uncertainties about an unknown quantity, uncertainties regarding what the consequences of an activity will be, and uncertainty related to a phenomenon, for example related to cause-effect relationships. The challenge we face is to conceptualise uncertainty and then to measure it. It is argued that uncertainty about a quantity or what the consequences of an activity will be, is about not knowing the value of this quantity and not knowing what the consequences will be, and that measurement of this uncertainty leads to concepts like probability, interval probability and possibility, as well as characterisations of the knowledge that this measure is based on. For the uncertainty related to a phenomenon, various supporting concepts are discussed, such as scientific uncertainties and lack of predictability. Also the concept of model uncertainty is addressed.
The Role of Risk Analysis in Species Conservation

Environmental risk assessments can be used as tools to not only identify potential threats to species of interest, but also to support conservation efforts with an adaptive management framework. Adaptive management is a structured, decision-making process based on a feedback loop between data collection, analysis, and implementation of policies, actions, and ecological effects that is viewed as an effective way of using science to direct resource management and conservation efforts. The approach recognizes that decisions need to be made when there is uncertainty due to a limited understanding of complex, ecological systems, and all actions involve a potential risk. In practice, adaptive management requires directed monitoring and an assessment tool to evaluate ecological responses to management actions and whether those actions are achieving the desired objectives. Two case studies are presented that illustrate how Bayesian risk assessment models can be used to evaluate the impacts of environmental stressors, including non-indigenous species, on populations of species that are being managed for conservation.

We evaluated risk from potential competition with non-native and native vegetation, plant demographic constraints, and habitat disturbances to an endemic, perennial grass whose habitat is restricted to isolated, scabland soils scattered within the Ochoco National Forest in central Oregon national forest. Our second case study evaluated the risk of impacts from an emerging disease on two species of endemic cutthroat trout across a regional distribution range. We demonstrate how Bayesian risk analysis models can be used to support adaptive management as an assessment tool for identifying sources of uncertainty, influential attributes, and evaluating the impacts of intervention strategies. Our case studies illustrate how Bayesian risk assessment models can be used to evaluate risk different spatial scales, and their utility in resource management and conservation.

Mindsets and climate change risk perceptions and action intentions

Psychological distance from climate change has been cast as the culprit for denial of and inaction on climate change in recent years. Those with climate change as far off in the future, hypothetical, and with impacts only on distant lands and distant people are unlikely to see the benefits of action on climate change as outweighing the (more proximate) costs, many argue. One mechanism proposed for this is mindset, whereby greater psychological distance is associated with a more abstract (and less concrete) mindset. Perceiving local extreme weather events as a manifestation of climate change would, according to this theory, result in a more concrete mindset, which would in turn influence preferences for action on climate change. The reverse causality should also hold, with mindset influencing perceived psychological distance. In this paper we present findings from four survey experiments in Norway and the U.S., including student samples from both countries, and a nationally representative sample of the Norwegian public. The experiments explore how more abstract versus more concrete mindsets may influence attitudes toward climate change and actions on climate change. Preliminary findings suggest that mindsets influence climate change attitudes and risk judgments, in expected directions. However, while simple communication strategies used in mindset research do appear to affect mindsets regarding climate change, prior mindsets seem likely to dominate their effects. Acknowledgements: Support from the University of Bergen and the Weyerhaeuser Endowed Chair at the University of Washington Evans School is gratefully acknowledged.

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Risk and Adaptation Incentives: Evidence from Global Hurricane Damages and Fatalities

The expected annual global damage from tropical cyclones (hurricanes) is $26 billion dollars plus 19,000 lives lost. The literature on tropical cyclones highlights the potential for ENP (Nanoparticles and heavy metals) in the environment to alter the natural ecosystem. We formulated the hypothesis that ENP and heavy metals in marine invertebrates can affect the immune and digestive gland functions. Although n-TiO2, has been shown to induce significant changes in digestive gland and immune parameters, the potential interactive effects of n-TiO2 and heavy metals have not been investigated in freshwater species. In this work, the effects of n-TiO2 exposure to mussels and digestive gland parameters were evaluated. The experiments demonstrated that combined exposure to n-TiO2/Cd2+ exerted mainly antagonistic and synergistic effects on immune and digestive gland function, depending on the endpoint measured. The results represent the first data on the interactive effects of ENP and heavy metals in marine invertebrates.

Interactive effects of n-TiO2 and Cd2+ in marine invertebrates

The increasing use of manufactured nanoparticles (ENP) in several strategic fields will lead to their release into the aquatic environment. Recent studies indicate that the biological impact of ENP may be due not only to the toxicity of ENP themselves, but also to their capacity to modify the bioavailability/bioconcentration/toxicity of other common environmental pollutants, such as organic xenobiotics and heavy metals. In the model marine mussel Mytilus, exposure to n-TiO2, has been shown to induce significant changes in different biomarkers from the molecular to the tissue level and to affect the immune and digestive gland functions. Although the possible interactive effects of n-TiO2 and heavy metals have been investigated in freshwater species, information is still lacking in marine organisms. In this work, the effects of n-TiO2 and Cd2+, alone and in combination, were investigated in M. galloprovincialis. The effects were first evaluated in vitro, on functional parameters of mussel hemocytes. 96 h in vivo experiments, exposed to n-TiO2 (100 ug L-1) and Cd2+ (100 ug L-1), alone and in combination, were carried out and hemolymph immune parameters as well as digestive gland lysosomal biomarkers were evaluated. The experiments demonstrated that combined exposure to n-TiO2/Cd2+ exerted mainly antagonistic and synergistic effects, on immune and digestive gland function, depending on the endpoint measured. The effects were then evaluated in vivo, on functional parameters of mussel hemocytes. 96 h in vivo experiments, exposed to n-TiO2 (100 ug L-1) and Cd2+ (100 ug L-1), alone and in combination, were carried out and hemolymph immune parameters as well as digestive gland lysosomal biomarkers were evaluated. The experiments demonstrated that combined exposure to n-TiO2/Cd2+ exerted mainly antagonistic and synergistic effects, on immune and digestive gland function, depending on the endpoint measured. The results represent the first data on the interactive effects of ENP and heavy metals in marine invertebrates.
Potential health risks associated with energy drink consumption and characterization of individual susceptibility factors

The popularity of energy drinks in the U.S. has grown over the past two decades and has become a multi-billion dollar industry. Although there is no generally accepted definition of energy drink, the American Beverage Association has reported the product to be a non-alcoholic beverage specifically marketed to have energizing effects. Energy drinks commonly contain caffeine, along with other ingredients such as taurine, guarana, and B-vitamins to create an “energy blend.” Health Canada has recommended a maximum daily intake value of 400 mg caffeine/day, and the FDA recommends a caffeine limit of 71 mg/12 ounces of beverage. In the U.S., most energy drinks are considered dietary supplements and are therefore not legally obligated to abide by the FDA recommendations for caffeine limits in beverages. Recently, reports of adverse health effects have raised concerns regarding the safety of energy drinks. Adverse health effects following the use of energy drinks. Caffeine metabolism can be influenced by diet, exercise, alcohol consumption, smoking, and use of certain medications (e.g., oral contraceptives). Furthermore, caffeine metabolism can vary according to body size, age, gender, genetic factors, and pre-existing health conditions such as liver disease. As such, certain populations may be at an increased risk for developing adverse health effects following the use of energy drinks. Caffeine metabolism can be influenced by diet, exercise, alcohol consumption, smoking, and use of certain medications (e.g., oral contraceptives). Furthermore, caffeine metabolism can vary according to body size, age, gender, genetic factors, and pre-existing health conditions such as liver disease. As such, certain populations may be at an increased risk for developing adverse health effects following the use of energy drinks. Uncertainty in energy drink consumption patterns and the lack of ingredient information and toxicity data for energy blends presents challenges in understanding the potential health risks associated with the intake of energy drinks. Additionally, although many popular energy drinks contain less caffeine per beverage than a cup of coffee, the combined effects of caffeine with other common energy drink ingredients are largely unknown. In this study we characterize the potential health risks that may be associated with energy drink consumption and describe individual risk factors that may increase an individual’s susceptibility to caffeine.

Estimating health expenditure by disease and injury, age, and sex, for the United States, 1996 - 2010

In 2010, the United States spent 2.6 trillion dollars on health care. Which diseases and injuries were responsible for this expenditure? While the US National Health Expenditure Accounts (NHEA) track overall health expenditure, these accounts are not disaggregated by disease. We estimate expenditure from 1996 to 2010 disaggregated by disease or injury as classified in the Global Burden of Disease 2010. First, we map the NHEA expenditure categories (functions) to align with the following service categories: inpatient services; public health and prevention services; health system administration; and an unallocated category. Second, we attain the distribution of expenditure by disease, age, and sex within each of these expenditure categories using patient-level microdata to estimate volume of encounters and unit prices of services consumed. For example, for inpatient services we obtain bed-days from the National Hospital Discharge Survey (NHDS) and average price per bed-day from the Nationwide Inpatient Sample (NIS), by disease. We smooth prices and volumes by age, sex and year as necessary. Using a regression-based approach we redistribute the disease specific expenditure estimates to adjust for comorbidity. Finally we confront the summed expenditure estimates from the micro data with the NHEA envelopes (control totals) to derive category-specific scaling factors. We use these disease expenditure estimates to track health system productivity growth, by relating trends in disease spends to the corresponding trends in health outcomes, measured in disability-adjusted life-years (DALYs), available from the GBD 2010 database.
**The Value of Information for Managing Contaminated Sediments**

Sediment remediation projects are often characterized by high degrees of complexity and uncertainty that make selection of optimal management alternatives difficult. Tradeoffs must be made across domains including, for example, environmental impacts, human health risks, societal benefits, and monetary costs. Furthermore, remediation decisions are often made in complicated political environments where stakeholders are sensitive to different outcomes. In many cases, further research may be desired to reduce uncertainties in hope of finding consensus solutions, but it is difficult to know in advance whether any produced information will be decision-relevant. We implement Value of Information (Vol) analysis, an extension of multi-criteria decision analysis (MCDA) streamline sediment-management decisions and add transparency to the decision process, but do not help to reduce uncertainty. Here, we apply Vol analysis to a contaminated-sediment remediation case in Grenland Fjord, Norway. The PROMETHEE II outranking algorithm is used to assess outcomes via MCDA, and Vol analysis examines the potential benefits of engaging in further research to learn more about the alternatives before committing resources to a specific decision. Results of simulated research to reduce uncertainties show average improved value for some (but not all) stakeholders from research in terms of decision relevance and expected impact on alternative outcomes. Tradeoffs must be made across domains including, for example, environmental impacts, human health risks, societal benefits, and monetary costs. Furthermore, remediation decisions are often made in complicated political environments where stakeholders are sensitive to different outcomes. In many cases, further research may be desired to reduce uncertainties in hope of finding consensus solutions, but it is difficult to know in advance whether any produced information will be decision-relevant. We implement Value of Information (Vol) analysis, an extension of MCDA, with Monte Carlo simulations to calculate the expected effect of different research strategies to prioritize research in terms of decision relevance and expected impact on alternative selection. In the past 10 years, Vol has been increasingly used for environmental applications and shows great promise for future sediment and environmental remediation decisions. In this presentation, we apply Vol analysis to a contaminated-sediment remediation case in Grenland Fjord, Norway. The PROMETHEE II outranking algorithm is used to assess outcomes via MCDA, and Vol analysis examines the potential benefits of engaging in further research to learn more about the alternatives before committing resources to a specific decision. Results of simulated research to reduce uncertainties show average improved value for some (but not all) stakeholders from research in terms of decision confidence stemming from a more-precise understanding of the problem and its relevant inputs.

**Health risk perception of wind turbines and opposition in Ontario**

Though the debate about the health impacts of wind turbines seems to be growing, health risk perception is rarely considered as a predictor of turbine opposition in the wind turbine literature. That literature suggests that visual aesthetics trump health concerns or that anticipatory fears abate once the turbines are built and become operational. We explore some of these ideas through two comparative Ontario case studies involving both surveys and interviews. One study compares data from a drop-off mail-back survey of 112 residents living near turbines in Melancthon/Amaranth with 104 residents from a nearby ‘control’ community (West Perth); while in the second study 16 interviews and 82 questionnaires in Port Burwell are compared with 8 interviews and 70 questionnaires in Clear Creek. Consistent with European findings there is majority support for turbines and generally low concern about health impacts from nearby residents, but this is combined a lack of majority support in the control community. Low support is tightly linked to health concerns. Yet, all of the communities share high levels of concern about Ontario policy particularly the siting process, community conflict and unfair benefits sharing. We will use the social amplification and attenuation of risk framework to help make sense of these and other findings and to explore policy alternatives.

**Understanding the Elements of Systematic Review and Evidence Integration**

The 2009 National Academies (NAS) report on formaldehyde was a game-changing report for the risk assessment field in that it pushed Agencies and stakeholders to take an approach that would be more systematic, objective, and transparent. Since that time, following principles from evidence-based medicine, evidence-based toxicology, and other areas, risk assessors have begun to adopt these approaches when evaluating environmental contaminants. In 2014, a second NAS report provided even more detail on recommendations for the conduct of systematic reviews and evidence integration analyses. Considering recent recommendations from the NAS, this talk will describe the basic elements and steps of systematic review and evidence integration, setting the stage for the audience to be able to understand and benchmark the forthcoming session talks which will show specific examples of how systematic review and evidence integration approaches have been implemented in individual case studies.
Increasing Scientific Confidence in AOPs: Tailoring the Bradford Hill Considerations for Evaluating Weight of Evidence

Consideration of scientific strength has emerged as a critical element in developing and, ultimately, using adverse outcome pathways (AOPs) for risk assessment. Weight of Evidence (WoE) has been proposed as a way for integrating information for AOPs, but methodology and tools associated with WoE applications for AOP have not been formalized. This work builds on and has contributed to enhancement of the OECD guidance for developing and assessing AOPs, and is expected to be additionally refined as greater experience is gained. Application to a number of case examples has led to additional development of an evolving template, which includes rank ordered tailored Bradford Hill (BH) considerations with defining questions and guidance for each. This presentation will describe the tailored Bradford Hill (BH) considerations to facilitate the ascertainment of a weight of evidence (WOE) confidence level (e.g., strong, moderate, weak) for key events/key event relationships (KEs, KERs) comprising AOPs, as well as an entire AOP. We also clarified defining questions for each tailored BH consideration that an AOP developer would pose to the extent to which a given KER (or AOP) is scientifically supported. To emphasize this analysis, guidance on responses to the defining questions was developed to more explicitly capture the rationale for assigning levels of confidence. In rank order, the tailored BH considerations are 1) biological plausibility; 2) essentiality; 3) empirical support (dose-response, temporality, consistency); and 4) uncertainties/conflicting lines of evidence. (This abstract does not reflect policy of any of the authors’ organizations.)

Predictive Model for Baseline Mortality Rates in the United States

Environmental health impact assessments (HIAs) often require information on baseline mortality rates for affected populations. However, CDC nationwide death statistics are available only at the area level; lower level data, such as the San Joaquin County, California, Public Health Department’s Mortality Data Report, which collects decedent data only on race/ethnicity, but not income. A predictive mortality rate model can be used to better characterize variability in mortality rates across space or for special populations and improve the accuracy of HIAs. We used publicly available county-level data with national coverage from CDC, US Census Bureau, USEPA, USDA, USDOT, FBI, USDHHS, and Medicare to build a predictive model of 2010 all-cause mortality rates, stratified by age and sex. The dataset included 109,514 observations (death count by county, age group, and sex) and 214 predictors. We assumed a Poisson distribution for death counts and used Gradient Boosted Regression Trees (GBRT, a non-parametric machine learning method) for fitting. This model was evaluated against traditional regression models for count data. We also assessed the model’s downsampling performance by comparing zip-code level predictions with zip-code level crude death rates for Detroit, MI and Seattle, WA, obtained from the state public health departments. The GBRT-based model significantly outperformed traditional regression models in terms of fit. Its zip-code level predictions were agreed to 0.95% all age groups, except the very elderly. A predictive mortality rate model can use predictions of this model to better represent variability in mortality rates across subcounty areas (e.g., census tracts) or special populations (e.g., environmental justice groups, subsistence fishers), by characterizing these populations in terms of the 214 model predictors.

Benefit-Cost Analysis of California’s Hexavalent Chromium Drinking Water Standard

In April 2014, the California Department of Public Health (CDPH) issued a 10 ppb drinking water standard for hexavalent chromium (Cr(VI)), a natural constituent in California ground water. The OEHHA’s cancer risk assessment prepared by Cal/EPA’s Office of Environmental Health Hazard Assessment. OEHHA’s risk assessment is based on conventional bioassays in which rodents were exposed to high doses, and some developed small intestine cancers. Human risk at relevant concentrations was obtained by conventional extrapolation. Small intestine cancer is rare in humans, so the predictions of OEHHA’s risk model can be subjected to more than the usual amount of scrutiny. In this paper, the predictions of the OEHHA risk model are compared to actual small intestine cancer incidence, as reported to the California Cancer Registry. It is shown that OEHHA’s predicted low-dose cancer risk is implausibly high. Cancer incidence varies by about 2x across California counties. But Cr(VI) concentrations vary by much more; indeed, many public water systems have no detectable Cr(VI). It is shown that 20 ppb Cr(VI) is enough to “cause” perhaps 90% of the reported cancer incidence if the OEHHA risk model is correct. Where Cr(VI) exceeds 30 ppb, Cr(VI) “causes” more than 100% of all reported small intestine cancer cases, an impossible result. Meanwhile, counties with no Cr(VI) that have small intestine cancer rates cannot attribute any of these cases to Cr(VI). If the OEHHA risk model is correct, then the population in these counties must be exposed to something other than chromium. However, BCF has to be absent in jurisdictions where virtually all of the reported small intestine cancers are attributed to Cr(VI) ingestion.
Disasters are increasingly being understood as ‘processes’ and not discreet ‘events’. Moreover, the causes of disasters are driven by complex engineering, socio-economic, socio-cultural, and various geophysical factors. Such interacting driving factors, occurring across a range of temporal and spatial scales, combine in numerous ways to configure disaster risks. Using some selected disasters in Algeria, the dynamics of such risks and their configurations will be explored using a new approach and methodology, namely Forensic Disaster Investigations (also called FORIN methodology). The FORIN methodology came out of the recognition despite of the considerable increase in knowledge about disasters; unfortunately losses are not showing any corresponding decrease. Indeed, it seems, the more we have learned, the more we are losing. The FORIN methodology is based on the idea that this situation is due to the fact that much current research is still informed by a focus on surface symptoms of observations and events rather than critical causes and processes of disaster risk construction and accumulation. Forensic task is perhaps similar to solving a picture of a disaster puzzle. Initially, there are dozens or even hundreds of apparently disorganized pieces piled when examined individually, each piece may not provide much information. Methodically, the various pieces are sorted and patiently fitted together in a logical context taking into account all the parameters. Slowly, an overall picture of the disaster emerges. When a significant portion of the disaster puzzle has been solved, it then becomes easier to see where the remaining pieces fit. This paper attempts, as a case study, to investigate the M6.8 2003 Algiers earthquake. The main shock, which lasted about 40 sec caused the loss of 2,278 lives, injuring more than 11,450, making 250,000 homeless and destroyed or seriously damaged at least 200,000 housing units and about 6,000 public works.

Disinfection by-products (DBPs) are potentially harmful chemicals formed in drinking water by the reaction of naturally occurring organic matter with disinfectants aimed to kill microbial pathogens. Though numerous DBP species exist, only a few species have been examined in toxicological and epidemiological studies. Some of these studies suggest an association between DBP exposures in pregnant women and adverse births outcomes. In 2011, we completed an initial meta-analysis including 10 studies examining exposure to DBPs and the relationship with Small for Gestational Age (SGA) infants. We excluded studies from the meta-analysis if they had dichotomous exposure categories or surrogate measures such as disinfection type, water source or color, or were not in English. We scored the chosen studies (n=10) using a tool that evaluated analytical elements such as examination of confounding, outcome and exposure data quality including scores for temporal and spatial resolution of the exposure data. We analyzed for each study using a random effects model (OR=1.08, CI=1.03-1.13). Our effect estimates were consistent in magnitude with a previous meta-analysis based on earlier studies. Since preliminary analysis, eight more studies have been published that meet our selection criteria. In future analyses we will also evaluate the impact of different scoring criteria used to weight the available studies. This ongoing meta-analysis will inform weight of evidence characterizations for adverse outcomes related to smoking tobacco products. Further, reviews have included assessment of potential changes in composition or design and identifying characteristics that have been shown to influence dependence.
Can model simulations be used to reduce the domain of black swans?

The concept of "black swans" has gained increased attention in risk assessment and management. Different types of black swans have been presented, distinguishing between unknown unknowns (nothing in the past can point to its occurrence), unknown knowns (known to some, but not to relevant analysts) or known knowns that have been judged to be extremely unlikely and hence ignored. Events as the Macondo accident, the disappearance of flight MH730 and the Fukushima nuclear accidents have all been contributors to the increased attention. Traditional risk assessments have been questioned as their standard probabilistic methods may not be capable of predicting or at least identifying these rare and extreme events, creating the source of possible black swans. In this paper we will try to find previously unknown potential extreme events that if not identified and treated could occur as black swans. By manipulating a verified model used to evaluate the effect of hurricanes on the energy systems in the US; we try to identify hurricanes with potential extreme impacts, storms well beyond what the historic record suggests are possible in terms of impacts. The aim is to provide a framework based on reverse stress testing that can be used as a tool to identify possible extreme events that were unknown prior to the model simulations, and hence reduce the domain of a black swan.

Scientists' perceptions of public engagement and the need for theory development

The proposed research presentation would outline three years of survey data collection focused on understanding how scientists view public engagement. The goal would be to highlight theoretical and empirical questions that could be addressed to improve the quantity and quality of science/risk communication training. A tentative 'engagement perception and behavior' theory will be proposed based on the initial data. The underlying data collection is being done in cooperation with the American Association for the Advancement of Science (AAAS)(2012-2014) and several additional scientific societies (2014). The survey instrument used to date has been based on the Theory of Planned Behavior and thus includes measures for both past engagement behavior and future willingness to engage alongside measures of attitudes about engagement, perceived social norms related to engagement, and perceived efficacy of engagement. The social norms measures used included both descriptive and injunctive norms while the efficacy measures included both internal (i.e., skill) and external (i.e., engagement) efficacy. The 2012-2013 surveys (n = ~400, each) focused on online engagement and analyses looked at predictors of engagement quantity as well as the degree to which scientists viewed specific engagement goals (e.g., education, excitement generation, trust development, etc.) as priorities. The work suggests that scientists' efficacy beliefs are central to engagement quantity and endorsement of specific goals. The degree to which they perceive specific goals as ethical is also vital. The 2014 survey will shift the focus to face-to-face engagement and further explore how scientists conceptualize the role of goal-setting in science/risk communication. At a practical level, the work suggests that trying to foster more, higher quality public engagement by the scientific communication may benefit from emphasizing engagement impact and ethicality.
Multiple elicitations: the internal inconsistency of everyday decisions

Making good decisions requires the elicitation of individuals’ preferences regarding decision objectives, the alternatives under consideration, and the tradeoffs necessary in making a final selection. In this paper, we argue that multiple methods are required to identify a single method of elicitation as a “true” measure of preferences constructed during elicitation. Instead of typically considered common and relatively easy, also rely on methods (holistic ranking and attribute swing weighting) are interventions), uncovered using two prominent elicitation methods (the construction of ideal alternatives, holistic ranking of investigator-generated alternatives, and attribute swing weighting) demonstrated a majority of individuals’ preferences lack internal consistency. It was argued by those authors that the relative complexity and novelty of those decisions contribute to the construction of preferences during different processes of elicitation, as opposed to a simple uncovering of preferences. Building upon this work, the current study investigates the degree to which these preferences, as well as more everyday decisions (e.g., the purchase of vehicles, homes, and investment portfolios, as well as more everyday decisions (e.g., the purchase of vehicles, homes, and investment portfolios), uncovered using two prominent elicitation methods (holistic ranking and attribute swing weighting) are internally inconsistent. It is hypothesized that these decisions, typically considered common and relatively easy, also rely on preferences constructed during elicitation. Instead of identifying a single method of elicitation as a “true” measure of preferences, this paper argues that multiple methods are necessary to allow for multiple “constructions” and thus a more complete picture of individuals’ preferences.

Understanding and Mitigating the Impacts of Massive Relocations from Disasters

We have grown used to thinking of displaced persons as a developing-world problem. However, Hurricane Katrina and the Japanese tsunami/nuclear disaster made clear that even in the developed world, people may need to leave their homes due to natural/man-made disasters. This can occur for reasons ranging from nuclear accidents, to natural disasters (e.g., hurricanes), to terrorism (e.g., a major anthrax attack), to climate change (e.g., coastal flooding). In addition to the psychosocial consequences of forced relocation, massive relocation can have significant economic costs, including not only property damage, but also business interruption, loss of housing services, and decline of property values. Economic consequences can be expected to be highly nonlinear in both magnitude and duration of relocation. With regard to duration, a brief evacuation may be minimally disruptive, if people are able to return to their homes within a few days. A relocation of a few months or a year would be much more disruptive per day, but eventually, costs per day would diminish or approach zero, as the economy approaches a new normal. By contrast, costs can be expected to increase monotonically but not-linearly in the number of people needing to be relocated. Costs may also vary greatly depending on the nature of the assets that are interdicted. For example, loss of a major tourist resort may be almost completely compensated by increases in tourism at other destinations, while loss of housing or unique production facilities may cause significant costs until such time as replacements can be built. Unfortunately, disasters in populated areas can easily result in the need to relocate a million people or more. This argues for the need for research on interventions to encourage orderly and appropriate relocation before a disaster in areas under significant threat, to ensure that disaster relocation goes as smoothly as possible, and to increase resilience after massive relocation.

Calibration of Expert Judgments in Counter-terrorism Risk Assessment

This talk will assess the performance of various processes to assess important counter-terrorism values such as adversary intent and capabilities or target vulnerabilities, by eliciting and aggregating expert judgments used in homeland-security decision-making. In particular, we developed ten terrorism-related “seed questions” (whose true values are known from historical data), and asked the experts to give medians and prediction intervals reflecting their best estimates and levels of confidence (or uncertainty) about those seed variables. Alternative seed variables based on almanac data or U.S. statistics were also assessed, to determine whether expert calibration differs significantly between terrorism questions and general-knowledge questions. Consensus probability distributions for the various seed variables were then developed using a variety of methods. One class of methods assigns differing weights to the various experts based on their performance -- Cooke’s method (taking into account both calibration and informativeness), and Hora’s method (which focuses exclusively on calibration). We also explored various methods of broadening the experts’ prediction intervals to achieve good calibration (at the expense of informativeness), followed by equal weighting of all experts (since the broadened intervals would exhibit equal calibration for all experts). Results suggest that calibration is possible for experts (and of course, knowing the true values of the variables). Thus, expert judgment can be systematically integrated into homeland security decision making, and in particular to reduce the vulnerability to politicization (or claims of politicization) in the intelligence process. Since the methods described here were not designed for expert opinion based purely on empirical data, they provide a defensible and apolitical way of aggregating expert opinion.

Citizen priorities for environmental hazards: Understanding rankings and exploring their origins in risk perception

In ongoing discussions of environmental hazards, a controversial issue has been making sense of the priorities placed by citizens on various risks to the environment. This paper explores such priorities through competing theoretical lenses. Some scholars of risk perception have focused on demographic characteristics that undergird perceptions of risk, other scholars of risk perception have focused on the methods described here, while others, mainly scholars of risk communication, have looked at the role of media coverage in maintaining public attention on certain risks compared to others. Building on these sometimes conflicting perspectives, we undertook an analysis of original U.S. public opinion data with two questions in mind: Which of these perspectives provides the best explanatory mechanism for citizen priorities? And how can the perspectives complement one another in producing a better understanding of the origins of these priorities? Our preliminary results point toward a number of concrete conclusions as well as new questions. For one thing, worldviews based on political ideology and environmentalism show the strongest association with the choice of citizens in what environmental hazards pose the most immediate risks to the U.S. as a country. At the same time, the roles of trust in university scientists and attention to environmental issues in the news also show strong associations. Surprisingly, playing almost no role in shaping these preferences are indicators of socioeconomic status, religiosity, and factual scientific knowledge. Our analysis thus reveals that citizen preferences in naming environmental problems are based more strongly on distribution of values rather than in demographic characteristics or aspects of scientific literacy. Implications for social theories of risk are discussed.
A Review of Asbestos LOAEL and NOAEL Cumulative Exposure as a Basis for Lung Cancer Risk Characterization

In characterization of asbestos-related risks, it is critical to utilize the best knowledge about lowest-observed-adverse-effect level (LOAEL) and highest no-observed-adverse-effect level (NOAEL). In many cases, LOAEL and NOAEL represent one of the most valuable types of information about dose-response curve. In the presentation, different sources of bibliography will be reviewed to assess and reconcile data about asbestos LOAEL and NOAEL. It will be demonstrated how LOAEL and NOAEL for different mineral types of asbestos can be used to suggest an existence of a lung cancer threshold for asbestos-related exposure-response curve.

The complexity of critical infrastructures and the risk of black swans: some foundational reflections

Critical infrastructures, like the power grid, are complex systems upon which the human society strongly depends. Their protection is thus fundamental. The complexity, emergent behavior, and the large number of interactions within and between these systems make it difficult to know their response to deviations and perturbations, and the related outcomes. There could, for instance, be large, global cascading failures emerging from single, local events. From the point of view of risk analysis of these complex systems, we see that their modeling is affected by uncertainty due to insufficient knowledge about their behavior and consequences, with potential for large surprising events (black swans). Many approaches and tools are available to analyze systems for gaining knowledge on their behavior, in support to decision makers. The risk analysis effort is expected to produce a risk description to be presented to the decision makers, for instance, for ranking of resource allocation. However in doing so in common practice, little attention is given to the background knowledge of the risk description, and potential surprises that lack of it may lead to. This is related to the fact that it is common to consider risk as a combination of (expected) consequences and probability, and analysis is performed and reported accordingly. But the resulting quantitative numbers (or qualitative evaluations) are conditional on the knowledge base. In this paper a broader view on risk is taken where due attention is given to the knowledge base and potential surprises. Special attention is given to complexity of such systems and its relation with uncertainty, knowledge and potential black swans. Simple examples are used to illustrate the concepts.

Prospective and retrospective risk characterizations: obverse and reverse accounts

Typically occupational hygienists characterize chronic health hazard exposures by projecting current exposure conditions to future health risks over a working lifetime. Is it not equally valid to flip this projection model and look backward from the future such as when there is an interest in understanding current mortality or morbidity statistics, say in an epidemiological study, and whether there is an association with past exposures? Such a mortality or morbidity association cannot be made without some ability to characterize the past exposures for the individual or a larger population cohort. Further, more often than not when looking backward, there is little to no sampling data from which to easily characterize a working lifetime of exposure. Prospective as well as retrospective risk characterization models are based on cumulative exposure calculations the utility of which is dependent on meeting data quality objectives, the availability of empirical documentation, and consideration of the acceptable degree of uncertainty or safety factors. This presentation will explore modeling as a means of characterizing risk when attempting to understand past practices with regard to concentration, time, and duration.
Latent Health Effects of Marijuana from Exposure During Pregnancy & Breast Feeding

The endocannabinoid system undergoes development at approximately 14 weeks gestation. Stimulation of endocannabinoid receptors by marijuana in utero and in the breastfeeding infant has the potential to impact various parts of the brain that regulate movement, coordination, learning and memory. Most data regarding marijuana use in pregnancy and lactation are gathered through self-reporting, yet toxicity data indicate its use is much higher in the pregnant and breastfeeding population. This presentation will describe the prevalence of cannabis use in the pregnant population, determine the impact of marijuana on the fetus and newborn infant, explain the effects of in utero marijuana exposure on long-term growth and neurodevelopment, and provide recommendations regarding marijuana use in pregnancy and lactation. It is important for providers to understand the potential impact of marijuana in this vulnerable population and provide appropriate education regarding its use.

Can we define a concept of ‘risk tolerance’?

In 2007, Ortwin Renn suggested that ‘the most controversial phase of handling risk, including risk characterisation and evaluation, aims at judging a risk’s acceptability and/or tolerability’. The notion of which risks individuals and societies accept to run and which risks they refuse to take has been a central preoccupation of risk analysts at least since the seminal 1980s works by Paul Slovic and Baruch Fischhoff on How Safe is Safe Enough and Approaches to Acceptable Risk. Since Starr, acceptability has been framed predominantly as an equity (fairness) issue about the distribution of risks. Yet, what are the fair ways to organise these decisions? For Fischhoff (1994) if people accept a course of action despite knowing about the risks, then those risks might be termed acceptable. Those individuals may choose a riskier course of action and that risk should therefore be interpreted as a relative value based on the specific weighing of costs and benefits attached to a specific context. The attribution of this value raises the issue of ‘revealed’ and ‘expressed’ preferences. Risk perception studies have qualified and furthered this view by looking at people’s ‘expressed preferences’ in relation to risk-related, as well as situation-related patterns. When the risks are pervasive, surrounded by many uncertainties or ambiguities, or when the benefits are unclear or ill-defined, reaching an agreement becomes particularly difficult. In such cases, regulators and risk analysts have been particularly concerned about the need to justify risk acceptance on the basis of ‘objective’ criteria. From the UK to Norway and the Netherlands, probabilistic ‘tolerability’ models have been used. Yet, risk acceptability is by nature controversial and political; the idea that experts could be given the discretion to define tolerability according to their own standards is unlikely to be seen as a source of strength. This paper therefore envisages new ways to conceptualise ‘risk tolerance’ as an exercise situated in the political and social context.
To evaluate the impacts of oil and gas development on coupled human and natural systems (CHANS), we developed a framework to characterize and explore the implications of linkages between land use, climate, health and energy in the context of the land-water-energy nexus. Steps in the framework include characterizing the interactions between ecological, social, and economic domains and forecasting the effects of these interactions on the delivery of ecosystem services (ES) and the consequences of changes in ES on public health. Using a standardized information and data gathering process, we have characterized 58 ES/benefits potentially impacted by oil and gas development and 19 categories of information on each ES/benefit. This assessment includes the connections between ES/benefits, location along the supply chain of energy, the mechanisms and the scales of impact on environmental conditions and public health. Preliminary results are cast as a wicked problem in the context of a general model of threshold interactions across ecological, social, and economic domains, along three spatial scales. Wicked problems are created by uncertainty about future environmental conditions and social values, which makes it virtually impossible to define an optimal condition. In this context, the wicked problem resides in whether or not secondary problems may be created by changes in land use, energy demand, and water management on ES (and their generally positive outcomes at national and global levels) and the subsequent implications of these changes on public health, as a result of societal linkages to these changes. The conclusion discusses research needs for integrated approaches that decision-makers can use to examine the changes that particular policies can induce in the land-water-energy nexus, along with the resultant implications for public health.

Dealing with uncertainties in risk assessment: uncertainty typology and NUSAP

Many current policy issues that need to be addressed suffer from large uncertainties and high decision stakes (e.g. climate change). They require additional approaches to science than the ‘normal’ fundamental/applied science approaches, which consider uncertainty as provisional and reducible by further research. A new approach, termed ‘post-normal science’, views uncertainty as intrinsic part of complex systems that cannot always be quantified. One has to deal openly with deeper dimensions of uncertainty, and scientists, policy makers and stakeholders together need to find solutions while working deliberatively within imperfections. Several methods are available to this end, of which we adopted two to evaluate uncertainties in our quantitative assessments: uncertainty typology and NUSAP. The uncertainty typology structures characterization of uncertainty sources to support method-selection for subsequent coping. The characterization is based on multiple dimensions of uncertainty: location, nature, range, recognized ignorance, methodological unreliability and value diversity. The NUSAP-approach (‘Numeral, Unit, Spread, Assessment, and Pedigree’) is used to prioritize uncertainty sources. Experts judge the scientific rigor using pedigree-criteria and the influence on model outcomes, using a discrete 0–4 ordinal scale. Pedigree criteria are case-specific and depend on the type of uncertainty source (e.g., parameters, assumptions), examples being the influence of situational limitations, the plausibility, the choice space and agreement among experts. Our use of the combined methodology in three case studies yielded the following conclusions and experience: i) ranking of uncertainties feeds future research agendas, ii) uncertainty can stretch far beyond 95% intervals, iii) the methods increase the understanding of the models, also for non-modelers, and iv) a common language and short training of experts before the NUSAP workshop is required.

The Role of Marijuana in Cancer Development

There is substantial concern that medical or recreational use of marijuana may increase cancer risks, particularly for cancers associated with smoking such as lung cancer, head and neck squamous cell carcinoma, and bladder cancer. While smoked marijuana contains numerous carcinogens, the main psychoactive component of marijuana, tetrahydrocannabinol, does not appear to be carcinogenic. Population-based observation have yielded disparate results with regards to smoked marijuana use and cancer development. There are limited data regarding cancer risk non-smoked forms of marijuana use. This presentation will review the known literature about marijuana usage and cancer development.
**Sustainable Management of Nanomaterial Containing Wastes**

The novel properties of engineered nanomaterials (ENMs) are currently being exploited in a wide range of products, including pharmaceuticals, cosmetics, coating materials, electronics and catalysis. With the continued rapid growth of the nanotechnology sector, the volume and diversity of ENMs incorporated in products and ultimately released to solid waste and wastewater streams will increase substantially. ENMs may affect the performance of waste treatment methodologies, pose risks for human and environmental health, or may impact the acceptability of waste by-products, such as wastewater effluents or compost products. Additionally, the loss of valuable materials into waste streams presents both challenges and opportunities for reclamation that have yet to be explored. This paper presents the results of a three-day workshop with an interdisciplinary team of experts (including chemists, engineers, environmental scientists, toxicologists, social scientists and economists from the academic, business and regulatory sectors) aimed at understanding potential risks associated with ENMs in waste products, and developing approaches for waste management practices at the power plants.

**Health Expectancy versus Health Gap Measures: What difference Do At-Risk Population Dynamics Make?**

Two categories of summary measures of population health (SMPH) --- health expectancy (HE) and health-gap (HG) measures --- predominate as the yardsticks of choice for summarizing health impacts. For example the health impacts of tobacco cigarette smoking might be summarized with an estimate of the smoking attributable change in life-expectancy (a HE measure) or disability adjusted life years (a HG measure). Previous work has contrasted the HE and HG measures, revealing an approximate relationship for converting between the two. Key considerations enabling that derivation included normalization, age-standardization, and appropriate adjustment for time-dimension bounds on what events get counted. A fourth consideration, awaiting closer examination, is the distinction of a dynamic representation of the unfolding population health status (as captured by HE) versus a static (snap-shot) representation (as captured by HGs). While the HG’s snap-shot measure has been offered as a reasonable proxy for the annual impact that one might attribute to an intervention of interest (such as eliminating tobacco smoking), its overt neglect of time-dynamics subjects it to error. In this paper we study this error, identifying its mathematical origins, the determinants of its magnitude, and describing the conditions under which the error may make a material or negligible difference to a health impact estimate (and the comparability of HG and HE measures). Results will also be used to offer adjustment factors that can be applied to HG measures as a way to adjust for the neglect of this aspect of time-dynamics.
Comparative Weight of Evidence Approach for Limited Toxicity Data Chemicals

The Texas Commission on Environmental Quality (TCEQ) air permits program conducts a comprehensive review of permit applications or amendments to ensure that modeled impacts would not pose a concern to human health or welfare. Modeled chemical emission concentrations are compared to screening values called effects screening levels (ESLs). ESLs are chemical-specific air concentrations set to protect human health and welfare from adverse effects that could be induced by acute or chronic exposure. The amount of data available to derive these ESLs is highly variable. Of the approximately 5,300 screening values produced by the TCEQ, the vast majority represent limited toxicity data (LTD) chemicals, creating a need for a systematic, scientifically-defensible approach to derive ESL values for LTD chemicals. The TCEQ Guidance for Derivation of Toxicity Factors (RG-442) utilizes several different methods to derive ESLs for LTD chemicals, including surrogate, no-observed-adverse-effect level (NOAEL)-to-LC50 ratio, route-to-route extrapolation, relative potency, read-across, and NOAEL or lowest-observed-adverse-effect level (LOAEL) adjusted by safety factors approaches. However, the TCEQ guidance is broad in its scope and does not offer a detailed description of how different lines of evidence for LTD chemicals is integrated and prioritized. The goals of this presentation are to discuss the meaning of weight of evidence (WOE) in the context of LTD chemicals and describe various methods utilized to generate ESLs for these chemicals. We present a framework to provide a flexible and transparent comparative WOE approach for ESL derivation for LTD chemicals. This framework identifies how different elements of the body of evidence are evaluated and prioritized. Using methoxyisalanes as a model LTD chemical group, each of the aforementioned methods has strengths and uncertainties that must be considered in a case-by-case manner. This project provides a flexible framework that can be broadly applied to assist users in the derivation of toxicity factors for LTD chemicals.

Lessons from Combustion Particle Exposure Assessment for Engineered Nanoparticle Exposure Assessment

There continues to be growing concern about worker exposure to engineered nanoparticles in research, manufacturing, and end-user settings. In addition, the growing use of nanomaterials in consumer products has increased concern about exposure to product users and through environmental contamination. Exposures in occupational and non-occupational settings are not well-characterized due to the lack of standard assessment methods, the lack of inexpensive and portable sampling equipment, and lack of consensus about the appropriate exposure metric to use. In a parallel situation, exposure scientists have been struggling with characterizing exposures to ultrafine particles in ambient in indoor environments. Ultrafine particles are in the same size ranges as nanoparticles and in contrast to engineered nanoparticles are not purposefully produced but result from combustion processes, atmospheric reactions, and/or industrial sources (e.g. welding). The purpose of this paper is to discuss the lessons learned assessing exposures to ultrafine particles and how they would apply to assessing engineered nanoparticles.

Development of an Interspecies Nested Dose Response Model for Mycobacterium avium Subspecies Paratuberculosis

Mycobacterium avium subspecies paratuberculosis (MAP) is a zoonotic pathogen that causes chronic inflammation of the intestines. It is known to be the causative agent of Johne’s disease in the bovine host, and has been implicated as a causative agent of Crohn’s disease in humans. Thus far a quantitative microbial risk assessment (QMRA) model has not been developed for MAP, partially due to the lack of an optimized dose response model for this pathogen. This study was aimed at developing a dose response model for MAP, and if possible a nested dose response model for multiple species and strains. A total of four studies had sufficient data that passed quality assurance checks and could be used in dose response model optimization (exponential and beta Poisson). A nesting analysis was performed on the totality of permutations of candidate dose response models. Three of the four data sets demonstrated a goodness of fit to the beta Poisson model (and were best described with this model) and one data set showed goodness of fit and best fit to the exponential model. Two data sets could be successfully pooled in the nesting analysis resulting in a beta Poisson model with parameters $\& \#945; = 0.0978$ and $N50 = 2.70 \times 10^2$ CFU. This nested model is across two different host species; red deer and sheep, indicating the successful nesting. The dose response model also highlights the highly infective nature of MPA in ruminants and can be used for QMRA modeling of herd impacts as well as potential for human QMRA development given further future research.
Natural Hazards in Chile: Assessing Risk Perception and Social Trust on Governmental and Non-Governmental Institutions

Several studies suggest that risk perception and social trust in authorities and experts have a significant influence on preparedness actions undertaken by the population to face natural disasters. In order to support the development of local programs oriented at improving natural disaster preparedness, the present study aimed at: (i) assess the current levels of perceived risk and acceptability against various natural hazards (earthquakes, floods, landslides, wildfires, tsunamis, volcanic eruptions, extreme temperatures, droughts and storms), and (ii) characterize the degree of social trust in ten national institutions (four governmental institutions and six non-governmental institutions) responsible for natural hazards mitigation and management in Chile. Between July and October 2013, a survey was applied on statistically representative samples of the five major country’s cities (Iquique, Antofagasta, Santiago, Valparaíso and Concepción). A total of 2,009 people completed the survey satisfactorily. Our results suggest that: (i) the population of Concepción (city most affected by the mega-earthquake of February 27th, 2010) revealed the lowest perceived risk and lowest level of trust; (ii) residents of the city of Iquique (city currently exposed to the highest risk of earthquake and tsunami) showed the highest degree of acceptability and the greater level of trust; and (iii) compared with governmental institutions, non-governmental institutions achieved a degree of social trust significantly higher. The implications of these results are discussed.

Managing Chemical Risk through Alternatives Assessments: Case Studies and Current Initiatives

Alternatives Assessments can provide a framework by which to assess and understand the inherent hazards of chemicals of concern and compare them with the potential alternative chemicals for a specified functional use. The practice of alternatives assessment to inform the replacement of chemicals may pose at the product design phase. This presentation describes the alternatives assessment approach in California’s Safer Consumer Product Standard and REACH. Alternatives Assessments can be a useful tool for product manufacturers who are hoping to minimize the adverse health effects of their products by understanding the hazards certain chemicals may pose at the product design phase. This presentation will outline current initiatives in the field including the Interstate Chemical Clearinghouse Alternatives Assessment Guide and explain how these new initiatives are advancing the practice and understanding of alternatives assessment approaches.
The Adverse Outcome Pathway for Hepatic Toxicity and Tumorigenesis in Rodents by Sustained Activation of the Aryl Hydrocarbon Receptor

High levels of sustained activation of the aryl hydrocarbon receptor (AHR) eventually promotes liver tumors in rodents through a number of Key Events (KEs) including inhibition of intrafusal apoptosis, increased cell proliferation of previously initiated foci, proliferation of oval cells and extensive hepatic toxicity that provides for direct proliferative response and indirect proliferation secondary to regenerative repair. The Key Events, and their accompanying Associative Events and Modulatory Factors can be represented by dose-response transitions as well as being amenable to quantitative dose-response evaluations and risk assessment. An AOP for dioxin-like chemical-induced hepatotoxicity and tumor promotion will be presented, and potential applications in priority setting, read across and integrated approaches to testing and assessment will be discussed.

Effect of Probabilistic Methods on Human Health Ambient Water Quality Criteria

When using the traditional deterministic approach to deriving Ambient Water Quality Criteria (AWQC) protective of human health, point estimates are selected to represent exposure parameters such as body weight, drinking water intake, and fish consumption rate. Typically, high-end or maximum values are chosen to represent most of these parameters, which, when combined, lead to unlikely exposure scenarios and overestimates of potential risk. The phenomenon of a combination of high-end assumptions leading to an overestimate of risk is known as “compounded conservatism.” In contrast to the deterministic approach, the probabilistic approach accounts for variability within populations by allowing one or more of the exposure parameters to be defined as distributions of potential values. The result is a distribution of potential risk representing a range of possible exposures. The probabilistic approach, therefore, provides explicit estimates of potential risk for different segments of the population, including both the typical members of the population and individuals with high-end exposures. As long as one or more of the exposure parameters used to estimate risk is defined as a distribution of values, the outcome will be a distribution of estimated risks. To derive AWQC using the probabilistic approach, regulators need to determine the level of protection that will be afforded to a given segment of the population, recognizing that different segments of the population by definition will always have varying levels of potential risk. Consequently, the probabilistic approach explicitly separates risk assessment from risk management, greatly improving the transparency of the AWQC-setting process. This presentation describes how the probabilistic approach can be applied to the derivation of AWQC and that the resultant AWQC depend on one or more of the exposure parameters to be defined as distributions of potential values. The result is a distribution of potential risk representing a range of possible exposures. The probabilistic approach, therefore, provides explicit estimates of potential risk for different segments of the population, including both the typical members of the population and individuals with high-end exposures. As long as one or more of the exposure parameters used to estimate risk is defined as a distribution of values, the outcome will be a distribution of estimated risks. To derive AWQC using the probabilistic approach, regulators need to determine the level of protection that will be afforded to a given segment of the population, recognizing that different segments of the population by definition will always have varying levels of potential risk.
predict areas in the wildlife-livestock interface at high risk for contamination by enteric pathogens. Output data from FLAPS are available to end users through a web-based user interface.

**M2-D.3** Burns, WJ; Decision Research; william.burns@sbcglobal.net

**Commercial Airline Security: Public Perceptions and Communication Regarding TSA's expedited Screening Procedures**

A series of nationwide surveys were conducted, including a risk communication experiment, that focused on the TSA’s new expedited screening procedures. Findings indicated that while the public liked some aspects of the expedited screening, such as it being potentially quicker and less intrusive, there still remained concerns over whether it was less safe than the standard screening. More frequent travelers appeared less concerned with the new procedures. The public also appeared three times more likely to trust a government agency with personal information than a private vendor. TSA security officers (TSOs) appear to play a pivotal role in travelers’ perceptions of the TSA. They especially need to be skilled in communicating the value of TSA Pre-Check and also why passengers are on occasion chosen for additional screening. Taken as a whole, these findings suggest important ways on how best to communicate with the public regarding TSA policy and procedures. Recommendations for risk communication will be discussed.

**T2-J.6** Cacciatore, MA*; Yeo, SK; Scheufele, DA; Corley, EA; Brossard, D; Xenos, MA; University of Georgia; University of Wisconsin-Madison; Arizona State University; mcacciat@uga.edu

**Framing, priming and recency effects in risk communication: Exploring opinion formation of “post-normal” science**

Research on priming (Iyengar & Kinder, 1987; Scheufele, 2000; Scheufele & Tewksbury, 2007) has convincingly established that people’s evaluation of issues are influenced by the considerations that are most salient at the time of decision-making. This implies that individuals do not rely on all relevant information when forming opinions. Instead, they are susceptible to “accessibility biases” that cause them to over-sample from information that can be most easily retrieved from memory at the time of attitude formation (Iyengar, 1990). Often, the most salient information are the last pieces of information that an individual receives about a given topic – a phenomenon known as the recency effect. Priming and recency effects are especially important for “post-normal” science topics characterized by high degrees of uncertainty and low levels of public understanding (Funtowicz & Ravetz, 1993). In this study, we use data from an experiment embedded in an online nationally representative U.S. survey (N &amp;#8776; 1000) to explore citizen opinions toward a scientific risk topic. Using regression analysis, our study explores how framing and question wording manipulations impact public attitudes toward the labeling of nanotechnology-enabled consumer products. First, we found that respondents were more likely to agree that products containing nanotechnology should be labeled when an argument in favor of labeling was presented last, rather than first, within the survey question. Second, we found that exposure to risk frames was associated with a greater tendency to support the need for labeling. Finally, we found an interaction effect between news story frame and question wording such that exposure to a benefit frame about nanotechnology negated the recency effect outlined above. We offer possible explanations for these findings and discuss their implications for public involvement in policy making for the issue of nanotechnology specifically, and science and risk topics more broadly.
Cyber security risk assessment has been narrow in focus and based on a business risk assessment approach. However within a defensive environment, cyber security risk needs to be more holistic taking into account the user, information technology analyst, defender, and attacker. Cyber security risk assessment needs to consider the impacts well beyond the computers and network itself. To that end we have taken the 1996 Presidential Congressional Commission Framework for Risk Management, which incorporates standards from the environmental and human health risk assessment and framework. We illustrate how to apply those principles to the framing of cyber security risk: problem formulation, associated risks, examining options, decision-making, actions against risk, and evaluation. Problem formulation consists of identifying the assessment and management goals within the context of cyber security of a system. Associated risks are determined by the ability of the analyst and system to accurately detect the presence and severity of external and internal threats given the current state of the system. The options for action and the decision-making process consist of coordinated human and automated responses determined by the risk model and risk communication with the defenders. In cyber security defenders execute actions against the threats to achieve the desired state of the system, both as human decisions and as agile, probabilistic automated response. The state of the system is then evaluated to determine if additional action is needed to further secure the system. The successful implementation of this holistic cyber security risk assessment requires the development of measurement metrics for the information security attributes of confidentiality, integrity, and availability. A further challenge is determining what responses should be automated, and thus potentially subject to manipulation by attackers, and which decision-making remains fundamentally human. Besides, a behavioral component of the cyber security risk assessment accounts for the bounded rationality of human agents and for noisiness of the environment and decision-making process. The security research agenda must be expanded beyond elucidating and characterizing measurement metrics of the risk categories of vulnerability, likelihood of exploit, confidentiality, integrity, and availability.
Estimating the Effects of Climate Change on Highway Infrastructure Flood Damage

Climate change, already taking place, is expected to become more pronounced in the future. It is therefore important to understand the impacts of anticipated climate change scenarios on the transportation infrastructure, both its availability and use for freight and individual transport. Current damage assessment models, such as FEMA’s HAZUS, do not take transportation infrastructure into consideration, focusing instead on land parcels. Moreover, damage estimation models generally concentrate on overarching economic impacts, and often omit those associated with indirect impacts that may be experienced due to key roadway mobility interruption (e.g., delays in shipments, increased travel times and fuel costs). This presentation will focus on the results of a study undertaken to develop and pilot test a methodology that would identify key components of highway infrastructure that are most threatened from a suite of downscaled regional climate models, and estimate the actual costs of potential damages due to flooding to the infrastructure itself and related indirect effects. This research fulfills an important, unmet need for transportation infrastructure into consideration, focusing instead on land parcels. Moreover, damage estimation models generally concentrate on overarching economic impacts, and often omit those associated with indirect impacts that may be experienced due to key roadway mobility interruption (e.g., delays in shipments, increased travel times and fuel costs). This research fulfills an important, unmet need for transportation and community planning efforts in evaluating the potential impacts of climate change on highway transportation infrastructure systems due to flooding.

P.52 Cano, NA*; Fontecha, JE; Muñoz, F; Universidad de los Andes; na.cano744@uniandes.edu.co

Sectioning of transport pipelines for liquid hydrocarbons based on the minimization of costs related to environmental remediation as a consequence of accidental releases

Pipelines are usually used to transport liquid hydrocarbons due to the fact that they are considered one of the safest ways to achieve this task. Despite this fact the US DOT have reported 149 incidents until May for 2014, totaling $20,038,184 in property damage plus 6,296 net lost bbl. In order to minimize the risk, pipelines have shutdown systems involving shutdown valves for risk mitigation; thus the number and location of equipment are imperative in the design and management of the pipeline; especially for Colombian conditions, where topography is a main variable due to the mountain conditions. To do so some researchers have proposed optimizations based on the minimization of costs associated to environmental impact by optimizing the number or the location of valves. This proposes an alternative way of sectioning that differs from the standards and recommended practices on industry; for example 16 km is the distance proposed by the National Association of Pipeline Safety Representatives. This project have as output the optimal sectioning; both number and location of valves for liquid hydrocarbon transport pipelines, taking into account the cost associated to environmental remediation and the operational costs. Including parameters as: use of land, type of soil, type of hydrocarbon and operational restrictions, by the use of pool formation models and remediation costs. The results obtained differ from the standards recommendations and represent the minimum costs configuration. The purpose of the developed tool is to support the decision making process for risk management, based on technical data and concepts that include and take into account the particularities of the pipeline in which the tool is implemented.

M3-J.1 Canady, R; Center for Risk Science Innovation and Application, ILSI Research Foundation; rcanady@ilsi.org


A sharpened focus on risk analysis of risk perception transmission is proposed in order to improve public health. Causal links can be drawn between initiation of a risk perception in a population and adverse effects in cases such as reports of vaccine risk leading to lowered herd immunity and airline terrorism news leading to increased mortality from driving. Other examples have been discussed in this context at recent conferences including March 2014 at Harvard Center for Risk Analysis. These discussions have considered whether public health could be improved if there were accepted methods for 1) assessing and predicting actionable conditions leading to adverse health impacts, and 2) identifying where actions to mitigate such outcomes may be effective. Based on outcomes of expert workshops this paper will propose that elements of traditional risk assessment may apply to such evaluations. For example attributes for perceptions of risk can include potency of perception in causing a behavior leading to an effect; severity, likelihood, incidence of effects in populations; pathways of exposure; susceptible populations in terms of responding to messages and sensitivity to effects of responses; and externalities. Further findings are that methods drawn from behavioral economics and information flow analysis can be combined with exposure analysis and epidemiology to develop risk frameworks, as discussed by other papers in this symposium. Opportunities for risk management can be identified and acted upon to reduce health effects. Areas of focus for this work include medical practice, emerging technologies, food safety, energy production and use, and safety of chemicals and industrial materials. It is critical to note that the proposed research does not blame the recipient nor the messenger, but rather treats perception transmission through populations as having quantifiable and addressable public health risk.

M2-C.4 Cantor, RA*; Meer, S; Tyler, C; Berkeley Research Group; rcantor@brg-expert.com

What drives physician testing for pain medication compliance—risk or reward?

Millions of Americans are treated for chronic pain conditions with prescription medications. Opioids are generally prescribed to treat chronic pain. The extensive use of opioids has led to public health and drug crises concerns about non-medical use and abuse. Urine drug testing (UDT) is used by healthcare providers to assess user compliance with a prescribed drug regime. Compliance by patients has been linked to improved health outcomes and also to reduced opportunities for abuse or diversion of prescription drugs through illegal sales. Providers utilize UDT directly at the provider’s location and indirectly, through referrals to external commercial laboratories. UDT is reimbursed by public and private payers and the costs per patient can be considerable. This presentation reports the results of an empirical analysis of UDT utilization following substantial changes in the reimbursement values allowed by Medicare. Medicare is the largest single payer for UDT services related to chronic pain monitoring in the U.S. Changes to the Medicare reimbursement in 2010 and 2011 created a natural economic experiment to investigate the role of financial incentives on UDT methods and referral behavior. The results of this study raise public policy questions related to the influence of financial incentives on providers’ utilization of UDT and whether these incentives could adulterate clinical reasoning based on standard of care or risk reduction. In addition, the results have implications for the design of reimbursement structures and the continuing policy debate on factors driving physician choices in patient care.
P.79 Cao, H*; Lamberti, E; Mishra, A; Pradhan, AK; University of Maryland; hlcao@terpmail.umd.edu

Quantitative microbial risk assessment model for
antimicrobial resistant Salmonella enterica
Verocytotoxin-producing E. coli associated with
consumption of raw milk

Bacterial zoonoses Salmonella spp. and
verocytotoxin-producing E. coli (STEC) are among the top five
pathogens contributing to foodborne illnesses in the U.S. and
are responsible for substantial medical and economic burdens.
Raw milk is well-documented source of Salmonella, STEC, and
other pathogens. Recently, multi-drug resistant Salmonella
enterica serotype Newport has become a public health concern
and in 2006, this strain caused an outbreak with 85 illnesses
and 36 hospitalizations associated with raw milk cheese.
However, the risk of consuming raw milk contaminated with
antimicrobial resistant Salmonella and STEC has rarely been
quantified. The objective of this study was to estimate the
health impact of antimicrobial resistant Salmonella spp. and
STEC associated with consumption of raw milk. A systematic
literature review was done in order to collect data of
microbiological status of dairy farms and the relative
prevalence of antimicrobial resistant subpopulation. A risk
assessment model was developed and simulated using Monte
Carlo technique. On-farm processing, farm and retail storage,
transportation conditions, serving size, consumer drinking
preferences, etc. were considered in the exposure assessment.
The model was run for three main scenarios: milk directly
purchased from farms, milk purchased from farm store, and
milk purchased from retail store. The model outcomes were
expressed as DALY, a metric to quantify the burden of disease
from mortality and morbidity, probability of illness from a
single exposure, number of cases per year, severity matrix and
the increase of mortality due to resistance. This model aimed to
provide an estimate of the current health burden due to the
infections from antimicrobial resistant Salmonella and STEC,
to help identify crucial data gaps, and to highlight the value of
additional information on antimicrobial resistant pathogens in
the milk production and supply chain.

P.39 CARLADOUS, S; TACNET, JM*; BATTON-HUBERT, M;
CURT, C; Irstea - Snow Avalanche Engineering and Torrent
Control Research Unit; simon.carlados@irstea.fr

Assessment of risk mitigation measures effectiveness:
application to natural risks in mountains

Mitigation actions against natural risks in mountains are based
both on non-structural measures such as land-use control and
on structural measures such as civil engineering protection
works. To prevent or, at least, limit risks, protection works play
an essential part in reducing both the causes and effects of
phenomena. The analysis of their effectiveness is an essential
stage of the risk management process. Decision support tools
are needed to take into account their structural state and
functional effects on phenomena (stopping, braking, guiding,
diverting etc.) but also their economic efficiency, comparing
their construction and maintenance costs to direct and indirect
economic losses reduction. The concepts of dependability
analysis, functional analysis and failure modes and effects
analysis (FMEA), already used in civil engineering especially for
hydraulic dams, are extended to assess and evaluate the
structural and functional effectiveness of protection works. The
methodology elicits the expert reasoning process and evaluates
the danger level of the protection works. It uses of both
dependability analysis, an emerging technique for natural
hazards domain and uncertainty theories such as fuzzy logics,
possibility theory to take into account the imperfection of
information. Fuzzy intervals and possibility distributions are
used to assess the indicators that describe the possible failures
and the performance level of disposals. Indicators are defined
as information formalised so as to make its use repeatable and
reproducible. These indicators provide indications on a function
performance. Their implementation is based first on a system
description and on the proposal of indicators related to
structural and functional failure modes. The concept of risk, the
conditions and limits of cost-benefit analysis are discussed with
regard to the perfect of knowledge about frequency, physical
effects on phenomena, vulnerability curves and economic
valuations of losses.

T4-D.1 Capshaw, Z; Ferracini, T; Cardno ChemRisk;
zachary.capshaw@cardno.com

Dermal Risk Assessment for Phalates and Dermal
Absorption Potential

While the human health risks from phthalates are not fully
understood, they are currently being studied by a number of
U.S. government agencies including FDA, NIEHS, and NTP.
Certain phthalates, including diethyl hexyl phthalate or DEHP,
have been classified as probable carcinogens by some
organizations. Some phthalates have also been linked to
reproductive effects, although others have been designated as
creating “minimal concern.” An overview of the current
knowledge about dermal risk potential associated with
phthalates and implications of newly published data will be
discussed. Given that the use of phthalates in personal care
products remains prominent, a study was also conducted to
investigate the dermal uptake potential of phthalates from the
use of these products, and the results of this study will be
presented.

T4-C.5 Caruzzo, A*; Belderrain, MCN; Fisch, G; Young, GS;
Hanlon, CJ; Verlinde, J; Instituto Tecnologico de Aeronautica
(ITA), Instituto de Aeronautica e Espaco (IAE), Pennsylvania
State University (PSU); acaruzzo@ita.br

WEATHER RISK MANAGEMENT AND DECISION
ANALYSIS FOR TECHNOLOGICAL FACILITIES
PROTECTION: A NEW APPROACH

Weather and climate conditions can impact the operation of
technological facilities such as internet and telecommunications
systems or space launching centers. Such facilities have
mitigation plans for different weather events. However,
weather forecasts are uncertain, and have to be interpreted by
(different) humans. The selection of the best (potentially costly)
migration plan given a probabilistic forecast of an extreme
weather event is difficult, particularly with increasing
lead-times of the forecasts. Many papers present successful
procedures of weather risk and decision analysis. However, in
any real situation the challenge is to develop a Weather
Decision Support System that accounts for the preferences and
values of the decision makers and how those impact the
decision. We present a preliminarily discussion of how weather
forecast techniques may be applied in a decision analysis to
create this new index to aid decision-makers with mitigation
action decisions. In this paper we propose the development of a
new index, defined as Weather Decision Index (WDI).
Furthermore, it is possible to identify several applications of
WDI, including disaster risk reduction and climate change
adaptation.
Can Tumor Morphology and Molecular Pathology Assist in Identifying Causative Parameters in Lung Cancer When There Is More Than One "Exposure"?

Lung cancer causation demonstrates synergy for smoking and occupational exposures, including "asbestos". Models of effects of two or more exposures to occupational factors are complicated by uncertainties of exposure assessment complicate their use in identifying general and specific causation. Ideally, known mechanism of tumorogenesis would give better knowledge of causation. Tumor pathology may help in that regard. Tumor morphology (pathologic sub-type of lung cancer) and newer elements of tumor molecular biology (EGFR, ALK, etc.) can help in identification of tumors more likely to have smoking as sole or principal cause, and others where other exposures are more likely to contribute. Much knowledge in these areas has been generated from studies of "smokers vs. nonsmokers". Differing morphology or molecular biology has less associated uncertainty than exposure estimates, in that these involve "either / or" assessment in individual cases and are not affected by the subjective elements associated with exposure assessment. Early work and more current studies suggest that small cell lung carcinoma (SCLC) is most associated (98%) with smoking. More never smokers and fewer heavy smokers have been observed in case-control studies among patients with adenocarcinoma than for squamous cell or SCLC, but there is evidence of "mimicry" as well as different sub-types of SCLC. This diminishes marker usefulness in determining "which part" of causation is attributable to smoking, but new markers are being developed which may be more useful. Algorithms or rating schemes used to separate effects of occupational exposure, especially to "asbestos", can benefit by taking morphology and molecular biology into greater account.

Localized Perception on Wildfire Risk

I aim to test whether local perception of wildfire is significantly associated with scientifically measured wildfire risk. This study employs a spatial stratified random sampling scheme based on the respondents’ hazard zone and proximally to the WUI. This technique ensures a consistent representative sample of perceived risk relative to objective risk over the study area. Using multilevel model of responses from three states of public surveys combined with wildfire risk potential map, I investigate a possible relationship as well as socio-economic factors and other local scale factors at multi-scales. Results suggest that respondents who reside in areas with high exposure to wildfire describe themselves consistently with the scientific measure. Although the respondents recognized the existence of wildfire disaster in general, their perceptions about wildfire were more likely to be higher risk at the broader scale than surroundings at the local areas. In other words, the respondents were optimistic about a degree of wildfire risk in reality.
Exploring game-theoretic approaches for modeling transportation network security risks

Transportation networks may be utilized to deliver different types of physical attacks targeted toward an infrastructure asset or region. In some cases, various components of such networks, like bridges, may be the target in question. A defender with limited resources may choose to deploy certain protective resources along the paths leading to those assets. However, excess protection along access paths may in turn impede network flow. An intelligent attacker may seek to adversely impact the network structure and flow, attempt to avoid protective measures leading to the final target, or deliver the attack prematurely if interdicted. We explore several game-theoretic approaches that have been proposed over the past decade to address different facets within this problem space.

A Framework for Estimating the Impact of Cyber Threats to the U.S. Economy

Estimates of the consequences of cyber threats to the U.S. economy are important to both governments and the private sector. Governments require this information to inform policy and resource allocation priorities, and the private sector requires it to determine the marginal benefit of adopting additional security measures. Unfortunately, estimates by security vendors of the losses associated with one type of cyber threat, cybercrime—ranging from $250 billion for the theft of intellectual property costs to U.S. companies to $1 trillion for the global cost of cybercrime—have been criticized as unsupportable even by the researchers and experts listed as contributors. In response to such critiques, Anderson et al. (2012) developed a framework for measuring the cost of cybercrime in the United Kingdom in terms of criminal revenues, direct losses, indirect losses, and defense costs. Building on the Anderson (2012) study and the broader literature on economic impact analysis, this session will describe progress in developing a framework for estimating the impact of cyber threats to the U.S. economy, with a particular focus on specifying the exogenous shock of cyber threats for utilization in computable general equilibrium models.

Information Divergence: the Disconnection of Reporting Nuclear Risk and Crisis by the News Media in the U.S.

The news media, with its different outlets, is considered as the first source of information in cases of risk and crisis. The authors conceptualize risk and crisis as different events that required separate operations, protocols, and strategies, not only by governmental agencies but also by corporations involved in large-scale events, and the media which informs the general public. When crises develop, first responders (emergency and law enforcement) follow protocols to communicate with the public through the accredited media; and, governmental agencies and corporations with high-risk operations, also have developed their own protocols to inform the public. However, during the time of risk, the media does not provide a constant level of information to the public in terms of preparedness and responses. This paper explores in detail the connection between cyber operations companies in the U.S. Midwest and the press in reporting risks to their local communities and publics. The authors also demonstrate that while the Nuclear Regulatory Commission requires constant provision of information through the media, the changes in the media industry have not covered this issue properly. The paper provides a media perspective resulted from interviews conducted with reporters, journalists, and editors. Likewise, the paper produces a set of recommendations to enhance the flows of risk information in the case of risk, as well as for preparedness and response in case of a nuclear crisis.
P.89 Chiang, SY*; Wu, KY; China Medical University; sychiang@mail.cmu.edu.tw

Human health risk assessment of organophosphorus pesticide Methidathion

Methidathion is widely used organophosphate pesticide in a variety of horticulture industry. In this study, we carried out a consumers’ health risk assessment and occupational exposure risk assessment to methidathion. The toxicological profile of methidathion was extensively reviewed and updated. The Monte Carlo simulation was used to calculate the hazard indexes (HI) for customers, workers and farmers. For consumers’ health risk assessment, the means and upper 95% confidence limits of total HIs for methidathion in Citrus Fruit were greater than 1. For occupational exposure risk assessment, the distributions of exposures to methidathion were assessed based on personal sampling in 12 workers in the production factory and in 17 farmers who sprays methidathion from a backpack with a hand-compressed air pump or tractor-mounted applicators in the field. Blood and urine samples were also collected before and after work and analyzed by gas chromatography method. The inhalation HIs for workers and farmers were all less than 1. In contrast, the dermal HIs for workers and farmers were all greater than 1. Furthermore, our data demonstrate that the levels of methidathion in the blood or urine were markedly increased after work. Moreover, there is a good association between inhalation or dermal methidathion exposures and methidathion in blood or urine samples from farm workers. Our data support that the body burden of methidathion summarizes different routes of exposures, the total doses of methidathion absorbed would be a better biomarker of the potential health risk. Our results recommended to strengthen personal protective measures when spraying.

P.48 Chikaraiishi, M*; Fujitara, A; Hiroshima University; chikarashin@hiroshima-u.ac.jp

Risk perception of urban and transportation systems and its impacts on travel patterns and residential location preferences

Managing risks related to urban and transportation systems is not a simple task. Traffic accident can be a voluntary risk when public transport is available (such as public transport) and can be an involuntary risk when there is no alternative. The closures of schools and shopping centers may change travel patterns, affecting accident risk profiles. Suburbanization could make people difficult to rely on walking or cycling, affecting health risk profiles. Thus, changes in urban and transportation systems can influence traffic accident and health risks not only in a direct way, but also in an indirect way. People may perceive such direct/indirect risks and reflect them in their decision-making, but so far these have been little explored particularly from the perspective of urban planning. Thus, this study first explores risk perceptions of urban and transportation systems and their variations across different residential locations (rural, suburban, and urban areas). To characterize perceived risks of urban and transport systems, a questionnaire survey was conducted in Hiroshima, Japan. In the survey, we asked current residential location, travel behavior, individual/household characteristics, risk perceptions, and future residential location preferences. For the risk perception part, 12 types of risks were selected, including facility closures, transport accidents, and other transport-related risks (such as public transport). For each item, we asked 14 questions to characterize the risks, including subjective probability of the occurrence of the events within the next ten years, voluntariness of risk, responsibility distributions (i.e., who should take a responsibility for the risk), and so on. By using this data, we first characterize 12 risks by factor analysis, and then explore the impacts of the perceived risks on travel patterns and residential location choice, travel mode choice, and trip frequency decisions.

W4-E.4 Chimeddulam, D; Wu, KY*; National Taiwan University and Mongolian National University of Medical Science; chimeddulam@hsam-ac.mn

A Physiologically Based Pharmacokinetic (PBPK) Model for PFUnDA in Rats and Humans

The longer-carbon chain perfluorinated compounds (PFCs) were less studied, but, are of growing great concern in risk assessment due to their increasing environmental emissions and bioaccumulation in wildlife. To help risk assessment of PFCs in reducing the uncertainty and broadening the scope for other PFCs, we aimed to develop a physiologically based pharmacokinetic model (PBPK) for PFUnDA in rats and extrapolated to humans. A structure of a PBPK model was time-dependent and flow-limited and consists of five essential compartments: liver as a target organ for liver recirculation and protein binding of PFAAs, richly perfused tissues, poorly perfused tissues, poorly perfused tissues, kidney as a specific tissue for the excretion. Model development and simulation were performed by using software packages of MATLAB and Simulink graphical user interface (GUI). Tissue-blood partition coefficients were estimated based on the method of unified algorithm developed by Peyret et al. 2010. Michaelis-Menten kinetic parameters were used to describe the binding to liver protein and renal excretion and reabsorption, and the corresponding parameters were estimated by fitting the model. The developed models were validated by comparing the model predictions with the measured blood concentration time-course data for corresponding chemicals at the different dose levels. A PBPK model for PFUnDA in rats have been developed for the first time and validated. This new rat PBPK model is able to be used in the assessment of risk associated with human exposure predicting the internal dose of PFUnDA at the target organs of human body and toxicokinetic behavior of the chemicals through interspecies extrapolation. The interspecies extrapolation of rat PBPK model was successfully done using the interspecies allometric scaling in the physiological parameters of the human body and some adjustments in the chemical-specific biochemical parameters.

W4-E.4 Chiu, WA; U.S. Environmental Protection Agency; chiu.weihsueh@epa.gov


Current practices in characterizing uncertainty and variability in human health hazards of chemicals include application of uncertainty factors, use of margins of exposure, and linear extrapolation from a point of departure. In order to advance more quantitative approaches to characterizing uncertainty and variability, the WHO/IPCS has developed a framework for evaluating and expressing uncertainty in hazard characterization (known as “dose-response assessment” in the U.S.). Consistent with the Adverse Outcome Pathway concept, this new framework for characterizing uncertainty makes a key conceptual distinction between (a) individual dose-response, in which the magnitude of effect (M) changes with dose, and (b) population dose-response due to inter-individual variability, in which the population incidence (I) at a particular magnitude of effect changes with dose. The framework also requires choices for M and I to be made explicit and transparent, unlike most traditional approaches, resulting in a single “unified” quantitative approach for assessing stochastic (cancer-like), deterministic (threshold-like), and continuous endpoints. Depending on the risk assessment needs as driven by the problem formulation, increasingly complex approaches may be employed to evaluate and express uncertainty, including the use of probabilistic methods. The presentation will focus on the fundamental concepts underlying the WHO/IPCS framework, the implementation of probabilistic approaches, and the interpretation of the resulting probabilistic dose-response assessments.
Understanding Resilience of Metro Systems in Polycentric Megacities: A Case Study of Delhi Metro Rail System

Rapid urbanization in megacities has boosted the demand for transportation and strained infrastructure, especially in developing countries (ex. Delhi). In such latter megacities, random commuting patterns during peak hours and poor metro connectivity in the suburbs pose major challenges for building resilience in metro systems. We examine the Delhi Metro Rail System (DMRS) in India, for it is an expanding metro network in a polycentric city of a developing country. We analyze the metro network structure and model the dynamics of urban spatial structure by integrating graph theory approach with geospatial analysis. The DMRS is modeled as both an unweighted-undirected network (stations are nodes and rail connection are edges) and a weighted network (passenger traffic at different stations represents the weight). We identify topological properties of the DMRS network at each construction stage. In order to identify vulnerabilities of specific stations, we also develop a DMRS-geospatial model that includes information on the physical proximity of stations and the neighborhood employment data across the region. Our analysis describes the implications of node-level and network-level vulnerabilities for the design of resilient metro networks and highlights specific network features essential to build resilience of metro systems in polycentric cities.

Toxicology-based cancer causation analysis of CoCr-containing hip implants: A quantitative assessment of in vitro genotoxicity studies

Cobalt-chromium (CoCr) alloys have long been used in metal-containing hip implants because of their biocompatibility. Like all implanted metals, CoCr alloys undergo some degree of wear and corrosion in vivo, and as a result, implant patients typically have blood and tissue Co and Cr(III) concentrations that are a few-fold higher than background levels associated with dietary intake. Although to date epidemiology studies do not indicate an increased incidence of cancer in patients with hip implants, questions continue to be raised about the potential cancer risk posed by CoCr-containing implants. This analysis was conducted to determine whether the existing toxicology data support epidemiological findings. We evaluated the results of over 60 in vitro genotoxicity assays in human cell lines treated with Co and Cr(III) ions and particulate; endpoints included chromosomal aberrations, micronuclei formation, DNA breakage, and oxidative DNA damage. The in vitro concentrations at which genotoxic effects occurred (and did not occur) in these studies were compared to tissue concentrations of Co and Cr(III) that we conservatively estimated would exist in patients with normal functioning CoCr metal-on-metal (MoM) hip implants (wear rates of 1 mm3/year). For metal particulates, we found that in general, the minimum concentrations required to cause genotoxic effects in vitro (10^-4 – 10^-8 ug/g) were more than 1,000-fold higher than those likely present in tissues of implant patients; similar results were also obtained for Cr(III) ions. Thus, exposures to CoCr wear debris from MoM prostheses would not likely be genotoxic in vivo, and this is consistent with cancer epidemiology studies conducted to date.
Air dispersion modeling by Using Bayesian Statistics with Markov chain Monte Carlo Simulation to Estimate an Emission Rate from a Complex of Emission Sources

In the site-specific risk assessment, the air disperse model has been widely used to predict spatial distributions of pollutants emitted from a source. It requires the estimation of emission rates of pollutants of interests, which are frequently insufficient or available with dramatic uncertainty, particularly when assessment was conducted for a complex of petroleum plants. Therefore, a study was aimed to evaluate statistical estimation of emission rates from a cluster of petroleum chemical plants with air disperse modeling by using Bayesian statistics with Markov chain Monte Carlo (BS-MCMC) simulation. The Gaussian air pollutant dispersion model was adopted in this study to consider vertical distribution, physical/chemical processes. The local meteorological data and monitoring pollutants concentration data were used as prior information. BS-MCMC simulation was performed with the OpenBUG to estimate the posterior distributions of parameters and emission rates for the air pollutants. In this study, ethene emissions from Ynulin’s offshore industrial park in Taiwan have been estimated as an instance. The imported data were selected from air quality monitoring station in Taisi and Tainan which are including the wind direction, wind speed, stability, mixed height, and ethene concentrations. The standard deviation of lateral and vertical concentration distribution and emission rate can be obtained after 50,000 iterations with BS-MCMC simulation and the median of parameters are 719 m, 80 m, and 5101 ton/year, respectively. The results show that posterior distribution of emission rate theoretically converge to corresponding representative distributions for the site-specific petroleum plant so that quality of exposure assessment may be improved by reducing the uncertainty form the emission sources.

Efficiency, equity and environmental protection: a real world case from standard setting for thermal power plants

Chilean population is exposed to unsafe ambient air pollution levels across the country, with a significant impact on human health. Air pollution standards have been developed for different geographical areas easily and expeditiously, tool developed allows the evaluation of decontamination plans in 14 areas currently in saturation level (5) and other sectors (2). The model allows the individual and other abatement measures; Industrial and residential sources (62), mobile sources (18), fugitive sources (5) and other sectors (2). The model includes uncertainty analysis and provides valuable indicators of cost-effectiveness of each of the measures and also the plan in its entirety. The tool developed allows the evaluation of decontamination plans for different geographical areas easily and expeditiously, constituting an important tool for the Ministry of Environment in fulfilling their goals set.

Public Opinion on Energy Development: The Interplay of Issue Framing, Top-of-Mind Associations, and Political Ideology

In this study, we examine framing effects regarding unconventional oil and gas extraction using hydraulic fracturing (“fracking”): an issue involving considerable controversy over potential impacts as well as terminology used to describe it. Specifically, we explore how two commonly used terms to describe this issue - fracking or shale oil or gas development – serve as issue frames and influence public opinion. Extending existing research, we suggest that these frames elicit different top-of-mind associations that reflect positive or negative connotations and resonate with people’s political ideology. These associations, in turn, help explain direct and indirect framing effects on support/opposition as well as whether these effects differ by political ideology. Results of a split-ballot, national U.S. survey (N = 1,000) reveal that people are more supportive of shale oil or gas development than fracking, and this relationship is mediated by greater perceptions of benefit versus risk. Political ideology did not moderate these effects. Further analysis suggests these findings are partly explained by the tendency to associate fracking more with negative thoughts and shale oil or gas development more with positive thoughts. However, these associations did not vary by political ideology. We discuss implications for communicating risk regarding energy development.
**W2-G.2** CLIPPINGER, AJ; PETA International Science Consortium, Ltd.; AmyJC@piscitld.org.uk

**Advancing in vitro testing of nanomaterials with human-relevant exposure conditions**

A paradigm shift in toxicity testing is occurring with increased focus on the use of in vitro and in silico methods that evaluate changes in normal cellular signaling pathways using human cells or tissues. Consistent with the 2007 National Academy of Sciences landmark report “Toxicity Testing in the Twenty-first Century: A Vision and a Strategy”, a tiered testing approach including grouping considerations, computer modeling, high-throughput in vitro screening followed by testing in more complex three-dimensional microfluidic systems can be used to predict the toxicity of nanomaterials. In addition to using human-relevant systems, realistic exposure scenarios are critical. For example, for inhalation exposure studies, this may mean coating nanoparticles with lung surfactant before adding them to a test system, choosing relevant cell types, exposure at the air-liquid interface, and choosing a realistic dose range. Existing human data can be used to estimate realistic exposure to nanomaterials whenever possible; a range of doses around the estimated realistic exposure can be easily tested using multiple wells in in vitro test systems. Additionally, since physicochemical properties of nanomaterials dictate their toxicity potential, thorough characterization of the nanoparticles must take place not only for the particles in their pristine form, but also throughout their lifecycle (e.g., when added to the test system) and should be clearly reported when publishing the study results. Nano-specific considerations will be discussed such as thorough characterization, optimization and standardization of cell culture conditions, choosing an appropriate dose metric, and determination of cellular dose based on administered dose.

**W1-E.3** Cogger, N*; Jaros, P; Massey University; n.cogger@massey.ac.nz

**Risk based surveillance good in theory but how do we find the risky group?**

There has been a rapid acceptance of risk based surveillance in veterinary surveillance as such system should ensure rapid detection of animal and zoonotic disease. The key concept in development of a risk based surveillance system is that the risk of a hazard being present varies across populations and that sampling those populations with a higher risk is the most cost effective strategy to increase the likelihood of detecting a hazard. Intuitively, this is approach is appealing as it makes the best use of often scare resources. However, in practise the policy makers who must determine which groups should be sampled are often faced with limited data and discordance amongst experts. This paper will present a framework used to guide decision making about which wildlife species should be included in a risk based surveillance system designed to demonstrate that Great Britain was free for the food borne parasite Trichinella. A systematic review of the literature was used undertaken to determine whether or not the particular wildlife species being considered is a potential reservoir for Trichinella. A wildlife species was considered a reservoir for infection if it had been detected in the species when Trichinella was not present in domestic pigs at the time of the survey. The decision to focus on these studies was made because Trichinella is more likely to be present in wildlife when trichinellosis is endemic in the domestic pig population. The concepts used in this case study could be applied when designing a risk based surveillance system for other foodborne disease.

**W1-H.2** Cogliano, VJ; U.S. Environmental Protection Agency; cogliano.vincent@epa.gov

**IRIS and EPA’s Framework for Human Health Risk Assessment**

Assessments developed for EPA’s Integrated Risk Information System cover the hazard identification and dose-response assessment steps of a human health risk assessment. IRIS assessments are used by EPA’s program and regional offices for different purposes. Some purposes are not known when an IRIS assessment is developed, for example, an accidental release of a chemical into the environment or a new use of a chemical. Thus the general concept of an assessment that is “fit for purpose” must be understood as an IRIS assessment that is fit for multiple purposes. IRIS assessments include scoping and problem formulation phases that are responsive to recommendations from the National Research Council. In the scoping phase, the IRIS program asks EPA’s program and regional offices about their needs. This helps define the scope of an assessment, for example, whether to cover a single chemical or a larger group of related chemicals and whether toxicity values for all exposure routes are needed. In the problem formulation phase, the IRIS program is following recommendations from the National Research Council’s 2014 review of the IRIS process. This involves conducting an initial literature survey to identify putative adverse health outcomes and key issues, then releasing this preliminary information to the public for discussion and refinement. After scoping and problem formulation, the IRIS assessment is developed according to the enhanced IRIS process that is based on systematic review, public engagement, and peer review. This abstract does not necessarily represent the views or policies of the U.S. Environmental Protection Agency.

**M2-E.2** Coleman, ME; Coleman Scientific Consulting; peg@colemanscientific.org

**Exploring Disagreements Regarding Health Risks of Raw and Pasteurized Human and Bovine Milk**

While consuming both raw and pasteurized milk has been associated with cases of gastrointestinal illness, advances in microbial ecology including human and bovine microbiome projects suggest the need for reassessment of the common perception that pasteurized milk poses lower risk than raw milk. Knowledge of the role of diverse indigenous microbiota on skin and in the gastrointestinal tract of healthy people and animals is advancing to the stage that identification of the conditions under which the perception that pasteurized milk is “safer” may be true or false can be identified and explored. The milk microbiome is now known to contain more than seven hundred of species of bacteria, including non-pathogens (e.g., *Pseudomonas* spp.) and potential pathogens (e.g., *Campylobacter* spp., *Listeria* spp., *Staphylococcus* spp., *verotoxigenic Escherichia coli*). Comparative examples are based on available data and models for exposure to potential pathogens in raw and pasteurized milk, predictive microbiology for growth in non-sterie conditions, and dose-response relationships. This analysis illustrates analytic-deliberative process and provides implications for further research, risk management, and risk communication.
**T4-C.4 Connelly, EB*; Lambert, JH; Clarens, AF; Colosi, LM; University of Virginia; ec5vc@virginia.edu**

**Risk Analysis Methods as Roadmap for Engineering Innovations**

Research and Development (R&D) roadmaps have been employed by government, industry, and academia as decision aids and suggestions of topics for future work. Fast R&D roadmaps have spanned science and technology. Roadmaps serve to coordinate efforts across a variety of stakeholder groups. Thus, R&D initiatives should consider diverse stakeholder preferences and criteria for scientific innovations. Traditional risk analysis, multi-criteria decision analysis, and scenario analysis methods can be used to provide a robust prioritization of initiatives under uncertain future events. Application of these methods can be shown for energy infrastructure, aviation biofuel supply chains, and emergency preparedness.

**M2-E.1 Costard, S*; Groenendaal, H; Zagmutt, FJ; EpiX Analytics LLC, 1643 Spruce Street, Boulder CO 80302, USA; scostard@epixanalytics.com**

**Is raw milk safe? Quantitatively assessing the impact of raw milk consumption changes in the US.**

The increase in raw milk consumption in the US raises public health concerns. In this study, a stochastic model was built to estimate the risk of illness and hospitalization due to E. Coli STEC, Salmonella spp., Listeria monocytogenes and Campylobacter spp. associated with the consumption of milk and cheese. The rates of illness and hospitalization were estimated from historical outbreak reports, national statistics and surveys, as well as data from published studies. The public health impact of potential changes in raw milk consumption and prevalence changes of pathogens on dairy farms was assessed via scenario analysis. In the US, the consumption of milk and cheese was estimated to cause approximately 7,000 illnesses and 25 hospitalizations per year; mostly (64%) due to Campylobacter spp. Eighty-nine percent of these yearly illnesses were found to be due to the consumption of unpasteurized dairy products by just 3% of the US population. Overall, the mean risk of illness was estimated to be 212.7 times higher for consumers of raw milk (95%PI: 133.5 – 330.0). Moreover, more than 6,500 illnesses could be avoided each year if only pasteurized milk and cheese were consumed. The rates of hospitalization per billion servings of milk and cheese were also found to be considerably higher for unpasteurized dairy products than for pasteurized ones (Mean IRR: 72.3, 95%PI: 50.4 - 101.3). If the US population consuming unpasteurized milk and cheese was to double, the average number of yearly illnesses would increase by 88%. A reduction of prevalence of pathogens on raw milk farms could reduce the number of yearly illnesses; for example, a 50% reduction of prevalence would result in a 66% reduction of the incidence of illnesses. In conclusion, consuming raw milk and cheese causes a 200-fold higher risk of illness. The annual number of yearly illnesses would increase steadily as the numbers of raw milk consumers grow and this increase will be largely driven by campylobacteriosis.

**W4-G.2 Cote, I; U.S. Environmental Protection Agency; cote.lia@epa.gov**

**Potential New Approaches to Risk Assessment**

This talk will address efforts to use recent advances in molecular biology to better inform the next generation of risk assessments. The goal of this effort is to facilitate faster, less expensive and more robust assessments of potential public health effects. Among the methods highlighted are: quantitative-structure activity modeling; new high throughput in vitro assays; knowledge mining of databases containing molecular clinical studies and epidemiology; and probabilistic approaches to risk and uncertainty. Issues such as low exposure-dose-response and consideration of human variability and cumulative risk will be discussed.

**T4-H.2 Cowden, J; Rooney, A; Lee, J; Jones, R; Sams, R*; United States Environmental Protection Agency, RTP, North Carolina, United States. ; sams.reeder@epa.gov**

**New approaches for Human Health Risk Assessment: Inorganic Arsenic as a Case Study**

The United States Environmental Protection Agency’s (USEPA) National Center for Environmental Assessment (NCEA) is developing a human health assessment for inorganic arsenic (iAs). The assessment will consist of hazard identification and dose-response assessment. In developing the assessment, the USEPA is committed to implementing recommendations received from the National Research Council (NRC) in several recent reports (NRC, 2014; 2013; 2011; 2009). Among these recommendations, NRC stressed the importance of transparency both within the process as well as in risk assessment documents. New approaches are being implemented for scoping and assessment planning, stakeholder engagement, natural language processing for literature searching, risk of bias (ROB) evaluations for individual studies, causality determination, study quality, adverse outcome pathway(s) and dose-response analysis. Available scientific and mechanistic information will be organized into an adverse outcome pathway(s) including the characterization of potential susceptibilities. Dose-response analyses will be performed on endpoints for which arsenic is determined to be ‘causal’ or ‘likely causal’ using a causality framework. Probabilistic methods will be incorporated into the dose-response analyses when the necessary data are available. These probabilistic approaches are being used to characterize the uncertainty and variability in the dose-response analysis, including dose-estimation, model selection, and individual and population susceptibility. This presentation will provide an overview of new assessment development methods currently being implemented in the iAs assessment. The views expressed in this abstract are those of the authors and do not necessarily represent the views or policies of the U.S. Environmental Protection Agency.
Determining Risk Thresholds for TSA’s Risk Based Security

TSA is well along in implementing its "risk-based security" strategy. The strategy includes the introduction of voluntary, information-based pre-screening wherein a passenger voluntarily provides information about themselves to allow TSA to perform a risk assessment which could provide access to expedited screening at the airport. A core issue with risk-based screening is determining an appropriate and defensible risk threshold. We discuss different approaches to choosing a risk threshold for pre-screening programs within the overall operational context of aviation security.

The Value of Risk Reduction: New Tools for an Old Problem

The relationship between willingness to pay (WTP) to reduce the probability of an adverse event and the degree of risk aversion is ambiguous. The ambiguity arises because paying for protection worsens the outcome in the event the adverse event occurs, which influences the expected marginal utility of wealth. Using the concept of downside risk aversion or prudence, we characterize the marginal WTP to reduce the probability of the adverse event as the product of WTP in the case of risk neutrality and an adjustment factor. For the univariate case (e.g., risk of financial loss), the adjustment factor depends on risk aversion and prudence with respect to wealth. For the bivariate case (e.g., risk of death or illness), the adjustment factor depends on risk aversion and cross-prudence in wealth.

Reducing Over-Valuation of Risk Regulations with Highly Uncertain Benefits

Ambiguity-aversion and related decision biases can distort cost-benefit evaluations of regulations proposed to reduce uncertain risks, leading to predictable regrettable risk management decisions. This paper argues that the confluence of several well-documented decision biases leads to individual and collective learning-aversion, i.e., insufficient information-seeking and use and premature decision-making in the face of high uncertainty about the costs, risks, and benefits of proposed changes. Ambiguity-averse preferences, together with other biases such as overconfidence, confirmation bias, optimism bias, and hyperbolic discounting of the immediate costs and delayed benefits of learning, contribute to deficient individual and group learning, avoidance of information-seeking, under-estimation of the value of further information, over-reliance on current beliefs, and hence needlessly inaccurate risk-cost-benefit estimates and sub-optimal risk management decisions. In practice, such biases can encourage selection of risk-reducing regulations that will, with high probability, prove less attractive in hindsight than they do when chosen. Low-regret learning strategies (based on ideas from computational reinforcement learning models) can improve some of these sub-optimal decision processes by replacing aversion to uncertain probabilities with optimized learning, i.e., with actions calculated as a balance of exploration (deliberate experimentation and uncertainty reduction) and exploitation (taking actions to maximize the sum of expected immediate reward, expected discounted future rewards, and value of information). We illustrate low-regret learning strategies for overcoming learning-aversion using regulation of air pollutants as a case study.

Adversary Modeling in Stackelberg Security Games

Stackelberg Security Games (SSG) has been used to model defender-attacker relationship for analyzing real-world security resource allocation problems. Specifically, a leader first allocates security resources with a mixed-strategy; a follower, in turn, chooses a target to attack based on the observations of the security policy. Research has focused on generating algorithms that are optimal and efficient for defenders, based on a presumed model of adversary choices. However, little has been done descriptively to investigate how well those models capture adversary choices and psychological assumptions about adversary decision making. This study aims to explore adversary choices by comparing different adversary models in SSG setting. Using data from 3 experiments, including over 1000 human subjects, over 100 payoff matrices and over 25000 plays of games, 9 models were evaluated nomothetically and ideographically. The 9 models were all based on the softmax choice model (related to Luce’s choice axiom) to obtain the probability of choosing a particular target. The models vary in terms of the evaluation functions, which can be partitioned into 5 categories: (1) EU (2) EU accounting for risk attitude (3) Lens model with a weighted average of cues: p(success), attacker’s reward and penalty and defender’s reward and penalty (4) Lens model accounting for risk attitude and (5) Multi-attribute utility model with a weighted average of p(success), attacker’s EU and defender’s EU. We found lambdas were close to 0 for all models in all experiments, which indicated that participants tended to be consistent with maximizing their evaluation functions in all 5 model categories. We also found that participants tended to avoid a target with high probability of being protected even if the reward or expected value of that target is high. It was also found in two experiments that adversary choices were dependent on the defender’s payoffs, even after accounting for attacker’s own payoffs.

December 7-10, 2014 - Denver, CO
Labeling of genetically modified (GM) foods is a contentious and politically-charged topic. Two-state-wide referenda have been held, and related legislation has been introduced in over 20 states since the topic continues to be hotly debated. To understand what Americans know about GM foods and how they feel about GM labeling, we conducted a national online survey of a randomly selected panel of 1143 Americans using the KnowledgePanel®. The survey was conducted in October 2013. Most Americans (55%) say that they know little about GM foods, and exactly half (50%) say that they are unsure of their opinion of plant-based GM foods (with less uncertainty and more negativity about animal-based GM foods). Using three separate questions to assess whether the public supports GM labeling, we found that support for labeling depends on how the questions are asked. Only 7% mention GM foods in an open-ended question about what additional information should appear on food labels. However, when asked about the importance of various labels, 59% of respondents rated GM labels as “extremely” or “very important.” Finally, when asked directly if they believe GM foods should be labeled, 73% say “yes” and 10% say “no,” while 17% say that they don’t know. Logistic regression indicates that disapproval of plant- and animal-based GM foods are both strongly predictive of support for labeling, and (8) self-assessed knowledge about GM foods, as well as demographics such as gender, age, education, and ethnicity, were not significantly related to support for labeling. The findings suggest that on issues where there is a lot of uncertainty, such as perceptions of GM foods, question wording can have a dramatic effect on responses.


economic losses from disasters for different sources of electricity generation, including renewable energy generation and different degrees of centralization. The intellectual merit lies in this new method and in the insights it can generate. This method will improve the estimation of electricity infrastructure–related losses for disaster planning and offer additional and improved data to be used in policy making and for urban planners. Their decision will be more informed and lead to better outcomes. Knowing the impact of renewables and decentralization, decision makers can recommend and incentivize the development of the most resilient electricity infrastructure. Quantitative evaluation of these benefits enables decision makers to engage in cost-benefit analyses. The research will be presented in the format of the current HAZUS software, the most widespread hazard loss estimation software, the potential public concern, (10) associated confidence level of expert judgements. This paper discusses the RES for each of the cases and highlights needs for future scenario-based evaluations of synthetic biology applications.

T4-K.1 Cuite, CL*; Hallman, WK; Morin, X; Rutgers, The State University of New Jersey; cuite@aesop.rutgers.edu
Support for Labelling of Genetically Modified Foods: How You Ask Matters

Duplic. Cuvillez, AL*; Fischer, M; Stanford University; cuvillez@stanford.edu
Contrasting Electricity Generation Methods for Disaster Resilience

When Hurricane Sandy hit New York City, a power outage left 8,661,527 customers without power and resulted in an estimated cost of $20 billion from business interruption. Power outages hurt customer loyalty and greatly inhibit economic recovery. Given this impact on society and the size of investments required for repair, it is imperative to take resilience of the electricity infrastructure to disasters into account when planning for the electricity infrastructure. The main proposed contribution of this research is a new methodology to model and evaluate economic losses from disasters for different sources of electricity generation, including renewable energy generation and different degrees of centralization. The intellectual merit lies in this new method and in the insights it can generate. This method will improve the estimation of electricity infrastructure–related losses for disaster planning and offer additional and improved data to be used in policy making and for urban planners. Their decision will be more informed and lead to better outcomes. Knowing the impact of renewables and decentralization, decision makers can recommend and incentivize the development of the most resilient electricity infrastructure. Quantitative evaluation of these benefits enables decision makers to engage in cost-benefit analyses. The research will be presented in the format of the current HAZUS software, the most widespread hazard loss estimation software, to allow for rapid dissemination and use of the results.

W3-E.4 Cummings, CL*; Kuzma, J; Nanyang Technological University; ccummings@ntu.edu.sg
Multidimensional risk profiling: A scenario-based evaluation of synthetic biology applications from a multidisciplinary expert Delphi study

Synthetic biology applies engineering principles to biology for the construction of novel or significantly-altered biological systems designed for useful purposes. One vision for SB is that it will provide benefits to society in multiple sectors; however it is also expected to be controversial for several reasons, including potential health, environmental, and societal issues as well as value-based objections (IRGC 2008; Van Est et al. 2007). This study reports findings from a three-round expert Delphi study (N=45). The expert panel was comprised of chemists, molecular biologists, engineers, sociologists, toxicologists, environmental scientists, lawyers, STS scholars, and policy specialists. The study assessed four synthetic biology case studies; biomining, cyberplasm, de-extinction, and engineered plant microbes (e.g. nitrogen-fixing bacterial symbionts). Following the work of Latxague et al. (2007) and Suffert et al (2009), the panel assessed each case study from a newly founded multidimensional risk evaluation scheme (RES) that featured 10 components: (1) current degree of certainty of EHS risks, (2) potential for human health hazards, (3) potential for environmental hazards, (4) manageability of potential hazards (5), degree that hazards are irreversible (6), degree of benefits to human health, (7) perceived degree of benefits to the environment, (8) degree of benefits to the economy, (9) environmental impact and different energy generation options when planning for the electricity infrastructure. Decision makers need to have access to methods for assessing different options for electricity infrastructure and electricity generation. At this point in time, there is no method that compares the benefits of having a more or less disaster-resilient electricity infrastructure. This research proposes to address this gap by investigating how decision makers can minimize disaster losses by considering the different energy generation options when planning for the electricity infrastructure. The main proposed contribution of this research is a new methodology to model and evaluate economic losses from disasters for different sources of electricity generation, including renewable energy generation and different degrees of centralization. The intellectual merit lies in this new method and in the insights it can generate. This method will improve the estimation of electricity infrastructure–related losses for disaster planning and offer additional and improved data to be used in policy making and for urban planners. Their decision will be more informed and lead to better outcomes. Knowing the impact of renewables and decentralization, decision makers can recommend and incentivize the development of the most resilient electricity infrastructure. Quantitative evaluation of these benefits enables decision makers to engage in cost-benefit analyses. The research will be presented in the format of the current HAZUS software, the most widespread hazard loss estimation software, to allow for rapid dissemination and use of the results.

P.49 Cuvillez, AL*; Fischer, M; Stanford University; cuvillez@stanford.edu
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When Hurricane Sandy hit New York City, a power outage left 8,661,527 customers without power and resulted in an estimated cost of $20 billion from business interruption. Power outages hurt customer loyalty and greatly inhibit economic recovery. Given this impact on society and the size of investments required for repair, it is imperative to take resilience of the electricity infrastructure to disasters into account when planning for the electricity infrastructure. The main proposed contribution of this research is a new methodology to model and evaluate economic losses from disasters for different sources of electricity generation, including renewable energy generation and different degrees of centralization. The intellectual merit lies in this new method and in the insights it can generate. This method will improve the estimation of electricity infrastructure–related losses for disaster planning and offer additional and improved data to be used in policy making and for urban planners. Their decision will be more informed and lead to better outcomes. Knowing the impact of renewables and decentralization, decision makers can recommend and incentivize the development of the most resilient electricity infrastructure. Quantitative evaluation of these benefits enables decision makers to engage in cost-benefit analyses. The research will be presented in the format of the current HAZUS software, the most widespread hazard loss estimation software, to allow for rapid dissemination and use of the results.
Solar photovoltaic (PV) power generation is one of the fastest growing technologies and a promising renewable energy source that offers the benefit of zero emissions during use. Concern has been expressed regarding end-of-life disposal of thin-film PV panels containing heavy metals, such as cadmium telluride (CdTe) PV panels. We present the first quantitative assessment of the potential human health risk associated with migration of cadmium from CdTe PV panels after landfill disposal. Specifically, a screening-level risk assessment tool was used to model the distribution and fate of cadmium in the environment and to estimate human health risk associated with multiple exposure pathways and routes. As an alternative to landfill disposal, some authors have presented PV panel recycling as a safer end-of-life option. End-of-life management of PV panels is based on many considerations including policies, economic factors, conservation of rare materials, and environmental and human health concerns. To help inform this process, a secondary goal of our study was to perform a quantitative comparison of the exposure potential and possible human health risks of landfill disposal versus recycling of CdTe PV panels. Based on our screening level risk assessment, landfill disposal of CdTe PV panels is currently not a human health concern. However, it will be important to re-assess the risk if the panel use and disposal rate increase markedly in the future. Regarding a comparison between landfill disposal and recycling of PV panels, our literature review of CdTe panel recycling revealed that there is currently insufficient information about CdTe panel recycling in the public literature to facilitate a quantitative comparison between these two end-of-life options.

Health and quality of life of people living near a chemical industrial area

Communities living near industrial areas are not only concerned about the risks related to the released toxic substances, but also about a set of production integrating odor, noise, visual aspects and accidental events. They usually report health complaints including a wide range of symptoms, diseases, and losses of quality of life. We present an epidemiological study performed on self-reported health and perceived pollution. A cross-sectional survey was conducted by phone interviews on a random sample of households, representative of the residents of the seven municipalities located within 5 km around the industrial area. The health outcomes were: general health (MOS SF-36), mental health (SCL-90-R), sleep disorders and symptoms which can result from irritating and/or allergenic properties of chemicals emitted by the industrial site. The exposure to industrial emissions was described, on the one hand, by modeling of the atmospheric dispersion of the chemicals and, on the other, through the sensory perception of the pollution from the site. The attitudes towards the industrial activities (beliefs, worries and behaviors) were studied as mediating factors in the relationship between psychological health and the perceived pollution according to the transactional theory of environmental stress. We assume that the perceived pollution has an adverse effect on self-reported health outcomes. Contrary to the usual transactional model of stress, we also assume that attitudes mediate these associations. The survey achieved a 52% response rate (n=1,495). The data analysis in progress will be presented during the conference. This study was designed to perform a comprehensive evaluation of a local public health issue. It is consistent with the multifactorial characteristics of the exposure to industrial activities, integrating psychological and social factors of health and risk perception.

Print media framing of risk perception: the case of Chronic Cerebrospinal Venous Insufficiency/Liberation Therapy procedure

The purpose of this presentation is to investigate how the print news media have communicated risks and benefits associated with a contentious and highly discussed procedure: the issue of Liberation Therapy (LT) as a treatment for a condition called Chronic Cerebrospinal Venous Insufficiency (CCSFI). CCSFI is a novel hypothesis involving people with multiple sclerosis. What emerged in the normal frame of a traditional scientific process was sensationalized in the Canadian print news media more so than in any other country-context. The procedure is not available as an insured service within the Canadian health system, nor has it received approval by Health Canada, the regulatory agency that is responsible to make these decisions. The perspectives of various key stakeholders surrounding the CCSFI / LT issue were portrayed very differently in the media. This presentation examines how the Canadian mainstream print media framed expert and ‘lay public’ voices on CCSFI/LT as a risky/not risky medical procedure. A dataset of news stories (n=378) from national and regional newspapers in Canada were analyzed from October 2009 – October 2013. These frames are compared to how some patients with multiple sclerosis discussed their understanding of the CCSFI / LT issue during focus groups held in a medium sized urban centre in June 2012 (n=37). Substantial gaps were identified in how experts, patients and the ‘lay public’ understood the associated risks of the procedure as well as in how they evaluated the actions of government bodies charged with the responsibility to make health decisions for Canadians.
Environmental Protection Agency. The views expressed in this abstract are those of the authors developing T2DM due to environmental and genetic factors. Exposures to heavy metals (e.g., water quality data, toxic) with other data identifying areas of potential increased transport based on its role in insulin production. Future on the C/T rs13266634 polymorphism of the SLC30A8 zinc identify hotspots of disease risk. Ultimately, this project focuses used to generate population attributable risk maps in order to Census data and geographic information systems (GIS) were for the individual subpopulations were calculated. Once PAR this information, the population attributable risk (PAR) values for the individual subpopulations were calculated. Once PAR values were calculated, this information was combined with Census data and geographic information systems (GIS) were used to generate population attributable risk maps in order to identify hotspots of disease risk. Ultimately, this project focuses on the rs13266634 polymorphism of the SLC30A8 zinc transporter based on its role in insulin production. Future extensions of this project would be to combine the risk maps with other data identifying areas of potential increased exposure to heavy metals (e.g., water quality data, toxic release inventory) to more fully characterize the risk of developing T2DM due to environmental and genetic factors. The views expressed in this abstract are those of the authors and do not necessarily reflect the views or policies of the U.S. Environmental Protection Agency.
P.185 DeBord, DG; Hoover, MD*; National Institute for Occupational Safety and Health; mhoover1@cdc.gov
NIOSH Center for Direct Reading and Sensor Technologies
To further increase its capabilities and partnerships to develop, validate and apply new technologies to assess and manage relevant occupational and environmental hazards, exposures and resultant health impacts, the National Institute for Occupational Safety and Health has established the NIOSH Center for Direct Reading and Sensor Technologies. The center serves as a hub for NIOSH’s longstanding work in the area of hazard and exposure assessment devices — work that is done across the Institute. Initial activities focus on 1) coordinating a national research agenda for direct reading and sensor technologies, 2) developing guidance documents pertinent to direct reading methods and sensors such as validation and performance characteristics, 3) development of training protocols and 4) establishing partnerships to collaborate in the Center’s activities. These activities recognize and capitalize on the fact that sensors are being used more frequently in many different settings from research to clinical practice. These activities also align with conclusions of the recent National Research Council report on Exposure Sciences for the 21st Century which identified direct reading methods and monitors as being an important driver for the future of the exposure sciences. Major questions include: Do direct-reading and sensor technologies accurately measure what they are supposed to be measuring? How can they be calibrated and validated? When are they limited to use for screening and when can they provide accurate characterization of specific hazards and exposures? And, finally, given the large amounts of data that may be created by such technologies, how can those data be feasibly collected, curated, analyzed and interpreted? NIOSH welcome partners and collaboration to ensure that sensors will be one of the technologies that can move exposure sciences forward at a rapid pace. Additional information about the center can be found at www.cdc.gov/niosh/topics/drst/.

W1-J.2 Demuth, JL; NCAR and Colorado State University; jdemuth@ucar.edu
Moving beyond "Have you experienced a tornado?": Developing a valid scale of past experiences for tornado risks
Hazardous weather, such as tornadoes, is common enough that it offers people opportunities to build reservoirs of experiences about how to react and what to do in the face of these oncoming hazards. Such experiences can be acquired directly by one’s personal participation in an event or indirectly by learning about others’ experiences. People’s past experiences are important to understand because they can influence how people perceive and respond to future risks. Although past experience has been examined in many studies of natural hazards, researchers have measured it in wide-ranging, inconsistent, and simple ways. Thus, key dimensions of past hazard experiences are not known, nor is it reliably known how one’s experiences relate to their assessment of future risks. This presentation will discuss an effort to develop a valid scale of past experiences in the context of tornado risks. Initial items were developed to measure past tornado experience, and they were evaluated through a mixed-mode survey of the public who live in the tornado-prone central United States. Open-ended survey questions elicited additional aspects of people’s past tornado experiences in their own words. This presentation will discuss the exploratory factor analysis of the initial close-ended items and the qualitative data analysis, and how these results are used to refine and test experience scale items on a subsequent public survey. The relationship between past tornado experience and people’s tornado risk perceptions also will be discussed. Findings from this research have the potential to inform tornado risk communication, which could enhance people’s future decision-making and protective responses.

M2-K.2 Demski, CC*; Pidgeon, NF; Parkhill, KP; Butler, C; Spence, A; Cardiff University; demskicc@cardiff.ac.uk
A new approach to 'public acceptability' and the risks of energy system change
Energy system change at a national or regional level is a problem currently facing many governments across the globe. It presents a complex set of issues which require innovative ways of thinking about the risks and benefits. The role of public involvement (including technical, economic and social risks). Scenarios of future energy system change often embed assumptions that new technologies and appropriate market instruments will be sufficient to ensure smooth transitions to a future low carbon energy system. This overlooks the important role that people will have to play in energy transitions. We therefore discuss ways in which social dimensions can be integrated into decision-making processes by drawing on findings from an interdisciplinary research project examining public perspectives on UK energy system change. This project involved major workshops held across the UK together with a nationally representative survey (n = 2,441). We develop two core arguments. First, we argue for a need to look beyond public acceptability of single technologies and their risks and benefits in isolation (e.g. nuclear, fossil fuels) and instead consider public perspectives with regards to the full set of transformations envisaged to occur over the coming decades. Second, we advocate a need to look beyond simple preferences and acceptability (e.g. risks and benefit perceptions) and more closely examine how such understandings are linked. We show that understanding values is more powerful than understanding what technologies people like or do not like (because such preferences can be ambiguous or variable depending upon context). Critically, public perspectives are not just about technology alone but about what the technology symbolises and represents, and must be understood also in terms of views on (e.g. distrust in) actors and processes embedded in system change. We argue that this brings important insights that provide a basis for improved societal dialogue and more robust decision-making.

M3-C.3 Deng, Q*; Baecher, G.B; Marr, W.A.; University of Maryland; gbbaecher@mac.com
Systems risk assessment of a Tokyo Bay oil storage terminal
Oil spills pose a serious threat to coastal environments and are expensive to remediate. Spills also give rise to regulatory penalties. Yet, out of logistical necessity, many refineries and storage terminals near the shores of these locations are subject to seismic hazards. A systems risk assessment of a facility in Tokyo Bay was undertaken to identify risk management options for the operators. The principal hazard is earthquakes triggering liquefaction in hydraulic fills at the site. This may lead to loss of chemicals offsite and financial consequences exceeding two billion 2014-dollars. The challenge was to characterize the fragility of the complete facility when operating as an engineered system, to quantify the probabilities and severities of possible spills, to establish the tolerability of spill risks of certain size, and to develop mitigation options. A combination of risk analysis tools was used to characterize the scope of problem, and a stochastic simulation was built to investigate systems engineering aspects of the site and of the terminal’s fragility when exposed to probable groundshaking. The facility consists of about 100 large tanks with capacities up to 50 thousand kl. These are arrayed in many interior patios with firewalls, with partial drainage among some patios to balance spill volumes, and all surrounded by exterior firewalls and revetment structures at the bay shore. Offsite spills into the Bay occur when any of a combinatorially large number of sets of sub-system failures occurs. The systems risk approach attempts to consider physical and functional interrelationships among the parts of the site and facility, and combines the analysis of the parts in their functional and spatial interrelationships in a unified way. The approach is easily transferable to many engineered infrastructure systems.

December 7-10, 2014 - Denver, CO
T2-A.3 Denkenberger, DC*; Pearce, JM; Global Catastrophic Risk Institute; david.denkenberger@colorado.edu

Feeding Everyone: Solving the Food Crisis in Event of Global Catastrophes that Kill Crops or Obscure the Sun

Mass human starvation is currently likely if global agricultural production is dramatically reduced for several years following a global crisis: e.g. super volcano, asteroid or comet impact, nuclear winter, abrupt climate change, super weed, extirpating crop pathogen, super bacterium, or super crop pest. This study summarizes the severity and probabilities of such scenarios, and provides an order of magnitude technical analysis comparing caloric requirements of all humans for five years with conversion of existing vegetation and fossil fuels to edible food. Here we present mechanisms for global-scale conversion including: natural gas-digesting bacteria, extracting food from leaves, and conversion of fibre by enzymes, mushroom or bacteria growth, or a two-step process involving partial decomposition of fibre by fungi and/or bacteria and feeding them to animals such as beetles, ruminants, rats and chickens. We perform an analysis to estimate the ramp rates for each option and the results show that careful planning and global cooperation could maintain the bulk of humanity and biodiversity.

M2-G.3 Deveau, M; University of Ottawa; michelle.deveau@uottawa.ca

Weight of evidence of proposed modes of action for tetrachloroethylene-induced liver tumors

The degree of confidence required for acceptance of a proposed mode of action (MOA) for a chemical will vary among individuals and organizations. Consequently, based on one dataset, some risk analysts might conclude the weight of evidence is sufficient to allow the MOA to quantitatively change the dose–response assessment, whereas others might presume that gaps preclude the use of the MOA to support risk assessment decisions. Discussions of potential MOAs for tetrachloroethylene (PERC)-induced hepatocellular tumors and their impact on human relevance and risk assessment outcomes will be presented to demonstrate potentially divergent interpretations of MOA data. A balanced case for and against each of the MOAs will be provided so the audience can understand the strengths and weaknesses of the proposed MOAs for PERC-induced hepatocellular tumors. During and at the conclusion of this presentation, the audience will be invited to provide their opinions on the level of confidence in the proposed MOAs and whether they interpret the weight of evidence to be sufficient to warrant acceptance of the proposed MOAs in a human health risk assessment.

W2-E.1 Dennis, S*; Chen, Y; Food and Drug Administration; Yuhuan.Chen@fda.hhs.gov

FDA/CFSAN framework for risk analysis: Challenges and opportunities for interactions

At FDA’s Center for Food Safety and Applied Nutrition (CFSAN), risk analysis is a valuable tool to enhance the scientific basis of regulatory decisions. Major food safety risk assessment are conducted by CFSAN and provide input within established risk analysis framework, where project goals are accomplished through the efforts of risk assessment, risk management, and risk communication teams (i.e., the risk analysis teams). The framework provides for a process to identify and decide when a risk assessment is needed and what type of risk assessment is needed. The importance of transparency is emphasized throughout the life cycle of a risk assessment, which encompasses commissioning, conducting, managing and reviewing activities. An open exchange of information and ideas (communication) within a risk team and among the risk analysis teams is critical for successful conduct of risk assessment projects. Furthermore, a great deal of efforts is made to identify stakeholders including consumer groups, industry, and other agencies early in the process to facilitate frequent communication with them during the assessment. This presentation will provide an overview of the implementation of the framework, and share insights on some challenges and key opportunities for interactions among the risk analysis teams as well as their interactions with stakeholders. These interactions lead not only the refinement of the risk assessment questions, key assumptions, and data used in the risk model to improve the quality of the risk assessments, but also the communication of risk assessment results in various formats that are more easily read and used to ensure the usefulness of risk assessments and the effectiveness of the public health policies they inform. The presentation will also touch upon ongoing efforts that FDA engages in to update the risk analysis framework with best practices and lessons learned from the last decade. [20 minutes]
W4-G.1 DeVito, MJ; National Toxicology Program; National Institute of Environmental Health Sciences; devitom2@niehs.nih.gov
Tox21:Implications for Toxicity Testing
As our knowledge of toxicology increased, newer testing methods were added to traditional toxicity tests in order to understand the potential health effects of chemicals in commerce. Despite the large number of chemicals required for chemicals in commerce, there are many adverse health effects, such as autism, for which our current testing paradigms cannot evaluate. It is also clear that these tests are time-consuming, expensive and produce results that can be challenging to extrapolate to humans. In collaboration with EPA’s National Center for Computational Toxicology, NIH’s Chemical Genomics Center, and the US FDA, the NTP has developed a high throughput screening (HTS) program that has evaluated over 8,000 chemicals in dozens of in vitro assays examining chemical effects on nuclear receptors, DNA damage, and stress pathways. We have also developed screening assays to further define and characterize activities identified from the initial HTS results. These screens comprise high content imaging assays using in vitro models and alternative animal models such as C. elegans and zebra fish. The use of HTS and alternative animal models allows us to identify chemicals that are biologically active and may require toxicity testing. To complement the HTS and alternative species data, short-term in vivo studies evaluating toxicogenomic changes. Using toxicogenomic changes as surrogates for toxic responses is consistent with the NAS’s vision of toxicity pathways and may provide a means of estimating a point of departure in the development of regulatory limits of exposure in a more efficient manner. A short-term in vivo study was performed to compare the comparison of the data from the HTS and alternative species to in vivo responses in a time frame that would allow for a refinement of these alternative testing paradigms. The utility of these approaches is under evaluation. (This research was supported by the Intramural Research Program of the NIH, NIEHS).

W3-G.3 Devlin, RB; US Environmental Protection Agency; devlin.robert@epa.gov
Use of Epigenetic Information in Risk Assessment
Chemicals in our environment are associated with numerous adverse health outcomes that affect growth and development, and the development or progression of diseases including cancer, diabetes, respiratory diseases, allergic diseases, and neurodegenerative disorders such as Parkinson and Alzheimer diseases. Many studies have shown that an individual’s health status is shaped by interactions between their genes and the environment because genetic variations in genes that are involved in relevant biological pathways can alter an individual’s susceptibility to environmental toxicants. However it has recently been shown that epigenetic changes, defined as changes to gene function that do not change the DNA sequence itself, can also shape an individual’s response to the environment. Epigenetics is the study of modifications of DNA sequences or function that direct which genes are expressed and which are silenced. This usually occurs through methylation of specific residues on the DNA, alterations in the histones which bind to DNA, or the production of small RNAs that can bind to specific DNA regions. Alterations to epigenetic patterns have been implicated in numerous diseases, especially cancer. Some of these alterations are labile and can be modulated by both acute and chronic environmental exposures, making epigenetics the interface between genes and the environment. Lifestyle factors such as smoking or obesity and SES factors could alter epigenetic patterns, making these individuals more responsive to a variety of insults including environmental pollutants. The goal of this talk is to describe the latest scientific evidence that exposure to environmental pollutants can alter epigenetic patterns which in turn affect expression of genes that control pathophysiological responses which contribute to adverse health outcomes. This abstract of a proposed presentation does not necessarily reflect EPA policy.

M2-J.3 Dieckmann, NF*; Johnson, B; Gregory, R; Mayorga, M; Han, PKJ; Slovic, P; Oregon Health & Science University; Decision Research; University of Oregon; Maine Medical Center; dieckman@ohsu.edu
Public Perceptions of Expert Disagreement: Expert Incompetence or a Complex and Random World?
Prior research has suggested that lay people will perceive expert disagreement as the result of either random errors or expert bias due to ideology or private interests. The few studies of this issue have been restricted to single domains, so it is unclear whether these results generalize. We used a psychometric approach to examine lay people’s perceptions of 56 different forecast topics from 7 domains (Health, Terrorism, Climate Change, Crime, Politics, Environmental, and Economics). Participants rated the forecast topics on the frequency of expert disagreement, the amount of irreducible randomness and complexity in the topic domain, and the extent to which experts are competent, unbiased, and willing to admit uncertainty. We stratified the sample by education/cognitive ability and self-reported knowledge in the forecast topics. We observed substantial variation in the perceived frequency of expert disagreement across topics. For participants with less education or lower scores on cognitive ability tests, ratings of irreducible randomness and complexity and expert bias were unique predictors of perceived expert disagreement. For participants with more education and higher scores on cognitive ability tests, ratings of irreducible randomness and complexity and expert bias were unique predictors of perceived expert disagreement. For participants with less education and lower scores on cognitive ability tests, and those who reported little knowledge about the topics, expert credibility/competence was the only unique predictor of expert disagreement. For participants with high self-reported knowledge in the forecast domains, only perception of expert bias from private interests and/or ideology and belief uniquely predicted expert disagreement. Thus only the highly educated appreciated the inherent complexities in forecasting that may lead to expert disagreement. The less educated and those who felt they had little knowledge about a topic required expert disagreement to the incompetence of experts. Participants who felt they had a lot of knowledge about the forecast topics related expert disagreement to experts being biased by ideology and private interests. We will discuss the implications of these findings for forecast communication.

P.99 Dieckmann, NF*; Johnson, B; Gregory, R; Mayorga, M; Han, PKJ; Slovic, P; Oregon Health & Science University; Decision Research; University of Oregon; Maine Medical Center; dieckman@ohsu.edu
Expectations of Expert Forecast Uncertainty Across Domains
Prior research on how lay people perceive uncertainty in expert estimates has assumed that these perceptions vary by domain, without directly testing the hypothesis that people may expect the same level of expert certainty regardless of domain. We used a psychometric approach to examine lay people’s perceptions of 56 different forecast topics from 7 domains (Health, Terrorism, Climate Change, Crime, Politics, Environmental, and Economics), which varied the prediction’s time horizon (six months to 50 years) and whether the forecast was binary (an event would or would not happen) or continuous (a point estimate of a continuous quantity). Participants rated the forecast topics on the likelihood of the accuracy and uncertainty in forecasts. They also rated the quality of the data in the domain, the frequency of expert disagreement, the amount of irreducible randomness and complexity in the topic domain, the extent to which experts are competent, unbiased, and willing to admit uncertainty, and personal knowledge and feelings. We use these results to probe the degree to which expected uncertainty in expert forecasts vary across domains and individuals, and what factors are associated with such beliefs.
**M4-B.2** Diener, Alan; Public Health Agency of Canada; alan.dieren@phac-aspc.gc.ca

**The Economic Burden of Illness in Canada**

The Economic Burden of Illness in Canada (EBIC) is a comprehensive cost-of-illness study that provides estimates of the direct and indirect, costs associated with illness and injury by diagnostic category, sex, age group, and province/territory. EBIC is the only comprehensive Canadian cost-of-illness study that provides comparable costing information for all major illnesses. EBIC results are available according to 24 diagnostic categories and 163 subcategories. Supplementing other health indicators, EBIC provides important evidence, and data, that when combined with information on outcomes, helps support public health policy and program planning. In this presentation we will focus on the most recently available data (2005-2008). For the direct costs, EBIC employs a top-down approach in which total health related expenditures are allocated according to diagnostic category based on the primary diagnosis. Indirect costs refer to the dollar value of lost production due to illness, injury or premature death. To estimate the indirect costs the friction cost approach was employed. In 2008, the estimated total economic burden of illness in Canada was $189 billion. Direct costs accounted for $172 billion (91%) and indirect costs for $16.9 billion (9%). The five diagnostic categories with the highest total costs in 2008 were neuropsychiatric conditions, cardiovascular diseases, injuries, musculoskeletal diseases, and digestive diseases. Together, the five diagnostic categories accounted for 92% of total costs.底

**T3-A.3** Dietz, T*; Henry, AD; Michigan State University; tdietz@msu.edu

**Challenges to Integrating Facts and Values in Adaptive Risk Management**

Integrating facts and values in adaptive risk management (ARM) is crucial to better decision making, however the literature provides many examples of management regimes that do not effectively bring facts and values to bear on important decisions. The result tends to be risk management decisions that are based on some but not all of the available science, and, or situations where hidden values drive conflicts over the legitimacy or appropriate interpretation of evidence. Numerous well-developed research traditions provide insight into particular aspects of this problem—these traditions include Institutional Analysis and Development, the Advocacy Coalition Framework, and the Values-Beliefs-Norms theory of environmental behavior. At the same time, these research traditions have evolved independently of one another, with disciplinary barriers slowing progress towards an integrative understanding. An integrative understanding is needed to develop practical strategies for effectively integrating facts and values in ARM. We review some of the major insights from the research literature and offer some initial suggestions towards a more integrative approach.

**W1-J.3** Dilling, L*; Berggren, J; Ravikumar, A; Andersson, K; University of Colorado Boulder; ldilling@colorado.edu

**The role of risk perception and other drivers in adaptation to weather and climate-related hazards at the municipal scale in the US Mountain West**

Cities are key sites of action for developing policies on adaptation to climate change. Recent research has focused on barriers to adaptation and documented the lack of adaptation implementation despite recognition of the importance of the issue at the international and national scale. Given the research already underway on barriers to adaptation, we chose to focus instead on the drivers of adaptation—why communities choose to take adaptive action. Because many communities are not yet engaged with climate change adaptation, we instead chose to focus on adaptation to existing natural hazards, such as floods, droughts, blizzards, and the like, as a model for understanding the drivers of adaptive behavior toward climate change risks. We studied U.S. municipalities in the intermountain west states of Colorado, Wyoming and Utah. These municipalities experience extreme climate events such as flooding, droughts, wildfires, blizzards, hailstorms, and tornadoes on a regular basis, some more recent examples being the Black Forest Fire and the 2013 Front Range Floods. To assess responses and planning to natural hazards and extreme events in the region, we conducted face-to-face and phone interviews with multiple key informants in a randomly selected sample of 60 municipalities with populations over 10,000. We asked about the perception of risk of weather and climate-related hazards, past events, responses taken (if any), planning activities, and the role of informal community groups, state and national policies, and other influences on municipal actions. We find that communities do indeed take a variety of actions in the face of weather- and climate-related risks, but that no single driver can explain differences in these actions. Rather, different drivers seem to correlate with different types of actions taken, and we suspect that combinations of drivers are necessary for adaptive action.
Near-Misses and the Challenges for Cyber Security

Dillon-Merrill, RL; Georgetown University; rld9@georgetown.edu

Much about cybersecurity technologies and practices is known but not put into practice. We believe one understudied factor is the impact of prior near-miss events. A near-miss may occur but if there are no salient cues of a possible bad outcome, people appear to mistake such good fortune as an indicator of system resiliency. In several studies, we study people’s reaction to near-miss events in the cyber-context. We discuss the implications of our studies for risk communication.

Decision Making

Near-Misses and the Challenges for Cyber Security

M4-D.1 Dillon-Merrill, RL; Georgetown University; rld9@georgetown.edu

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Risk Assessments

Exposure Modeling: Interpreting Results for Regulatory Risk Assessments

DiNovi, MJ; Government; michael.dinovi@fda.hhs.gov

Dietary exposure assessments range from the simple, one food type containing a substance at one concentration, to the highly complex, for example a contaminant that is found at low levels in many different food types with a high percentage of left censored data. The estimates from these differing assessments cannot simply be read and used intelligently in a potentially difficult risk assessment without the ability to explain the significance of assumptions used and uncertainties associated with the models. The impact of expert judgment will be examined through an exploration of three exposure assessments for substances of regulatory interest; from the simple to the highly complex, national and international.

Labeling GM Foods

The Influence of Procedural Justice on Support for Labeling GM Foods

Dixon, GN*; McComas, K; Besley, J; Washington State University, Cornell University, and Michigan State University; graham.n.dixon@gmail.com

The use of genetically modified (GM) foods in the U.S. has sparked considerable debate about potential risks to human health and the environment. Owing to these concerns, some have proposed that food companies should use labels to inform consumers if their products contain GM ingredients. However, many companies that produce GM products have declined to support such initiatives. Applying the concept of procedural justice, which underscores the importance that people place on having a voice in decisions that affect them, we examine how reporting the process used to make decisions about whether to label GM foods affects people’s support for the decision and the perceived legitimacy of that decision. Using a 2x2 factorial design, participants recruited from an online Qualtrics panel (n=450) were randomly assigned to read a fictitious news article about an agricultural company’s decision to label their food products as being GM. Articles were manipulated by the company’s labeling decision (label versus no label) and whether the company listened to public input prior to making the decision (public input versus no public input). The results showed significant main effects on decision support and perceived legitimacy for articles that mentioned public input. Specifically, when participants read articles that stated that the company listened to public input prior to making the decision (public input versus no public input), they were more supportive of the decision and perceived the decision as more legitimate. This main effect, moreover, occurred irrespective of whether the company’s decision was to label or not to label GM foods. Our results confirm the influence of procedural justice perceptions in fostering support and perceived legitimacy for controversial risk-related decisions.
T2-I.3 Doe, JB; DAIGLE, KJ*; American Society of Safety Engineers, Risk Assessment Institute; kenneth.daigle@bp.com
Risk Communication Challenges at the Worker Level - Making it Personal
This session focuses on the challenges of communicating risk assessment results to front line workers. Decision makers rely on risk assessment results to choose the most appropriate method(s) to manage risk. Risk assessments can vary greatly in size and complexity. The results of some assessments are straightforward and easy to understand. Others can be quite technical and the results difficult to explain. Risk assessment teams and decision makers often forget to consider how to best communicate the results to the front line worker. A communication that works for the decision maker does not necessarily work well for the front line worker. Front line workers have a very personal relationship with specific risks given they are the ones most exposed to injury and even death. They need to understand how the risk manifests itself, what are the possible range of outcomes, what controls are in place to manage the risk and what do they need to do to ensure those controls are maintained. This session will review a number of ways to effectively communicate the risk to front line workers using graphs or pictures; bow-ties, risk matrices and risk contour plots are some common methods. When these methods are linked to specific risk mitigation controls, a worker can more easily connect their action or responsibility with the risk and its potential impact on them personally. This increased understanding and appreciation of the risk and controls by front line workers results in better management of the overall business risks. At the end of the symposium session, we will reserve 15 minutes for Questions and Answers. Audience members will be able to ask questions regarding each of the presentations, as well as ask questions in a round table format such that each of the speakers will provide comments, as appropriate.

T2-I.2 Doe, JB; Newberry, JL*; American Society of Safety Engineers, Risk Assessment Institute; jnewberry@islandinsuranc.com
Risk Assessment Communication Challenges for the Occupational Risk Manager
This session involves a transportation and logistics company case study with 12 diversified divisions, including: household moving and storage; appliance delivery; records storage and retrieval, specialty freight; fuel and LNG hauling to name a few. A flow chart portraying a continuum of the risk & safety management development process from basic to mature was developed to help management understand what a safety/risk management system looked like. Up until this time, they had been resistant to learning about ANSI Z-10 (Occupational Health and Safety Management Systems), ANSI Z-15 (Safe Practices for Motor Vehicle Operations) and ANSI Z60 (Risk Management - Principles and Guidelines ANSI/ASSE/ISO 31000 [Z690.2-2011]). What I created for them was a visual, high level organization risk assessment map for management to understand the overall process. Management interventions included: First I had the executive management team identify what they thought they were doing well and; secondly I helped them identified the critical gaps that needed to be addressed to achieve their companywide goals. An action plan was developed from that current state to bring them along to their desired state, which was much further along the risk maturity continuum. Working at the top level of the organization had its initial limitations, so I also created some activities that I felt would meet in the middle as management was getting organized. I started at the crew level of the organization were, in cooperation with the new safety director, we created “prepare for the day” safety discussions. These sessions were very simple, relevant to the workers and involved them. We simply asked - what the moving crews anticipated the hazards or difficulties they might encounter on this day, with this load might be.

W4-A.4 Dolweerawatta, G; Arvai, J*; Marceau, DJ; Bergerson, JA; University of Calgary; gdolwe@ucalgary.ca
Development of a Multi-Attribute Decision Support Framework for Energy System Planning
Decisions about the design and development of energy systems are complex because they involve—among many factors—complex technical challenges; multiple stakeholders with conflicting objectives; long planning horizons; dynamic changes over time within social, economic, and environmental systems; and high levels of uncertainty. Some of the most significant challenges under these circumstances include identifying creative and—importantly—workable alternatives for policy makers and stakeholders to evaluate, and then reconciling tradeoffs across conflicting objectives when uncertainties are high. As part of an ongoing research project, we are developing and testing a decision support framework to help policy makers and stakeholders to navigate these complexities and challenges, and make decisions about energy systems that are more in line with stated priorities. To help address these goals, our framework knits together insights from four complementary scientific strands: work on (1) optimization, (2) modeled negotiations, and (3) spatial planning, and (4) decision aiding. In this presentation, we outline our work and our findings to date set in the context of a controversial case about hydro development and transmission line siting in Canada. We also draw conclusions from this research about how this decision support framework might be used in a wide range of other cases involving competing stakeholders and conflicting objectives.

T4-I.1 Dotson, GS*; Niemeier, RT; CDC/National Institute for Occupational Safety and Health/Education and Information Division; fya8@cdc.gov
Cumulative risk assessment: Bridging the gap between well-being and occupational safety and health
In recent years, occupational health professionals have recognized a link between the interaction of occupational-related stressors and non-occupational stressors on the overall health of workers. This realization has started a cultural shift in the realm of occupational safety and health that places a greater emphasis on risk management approaches based on the concept of well-being. One part of this new approach focuses on understanding the impact of co-exposures to multiple stressors, which has resulted in the need for new methods and tools capable of characterizing the interaction between different stressors and potentially quantifying the associated risks. One pathway to addressing these needs is to incorporate the practice of cumulative risk assessment, which involves assessing the aggregate and cumulative effects of simultaneous exposures to chemical and non-chemical stressors, into occupational risk analysis. Cumulative risk assessment has been applied in non-occupational settings, such as environmental and community risk assessments, but remains a nascent concept in the realm of occupational safety and health. This presentation will highlight the use of cumulative risk assessment as a risk-based approach to bridge the gap between the evolving culture of occupational safety and health and worker well-being.
First, a hazard range for each of the three endpoints was defined (i.e., endpoint-specific floor, midpoint and ceiling values) and "candidate" RfC (3 μg/m3; 2 & #956;g/m3; and 2 & #956;g/m3, respectively). Therefore, a hazard range for the TCE was established with 1000 mg/kg bw/d as the floor value, 3 μg/m3 as the midpoint value, and the most appropriate endpoint-specific ceiling value. The objectives of these GLP US EPA OPPTS 870.3800 studies were to discern the effects of TBBPA (10, 100 or 1000 mg/kg bw/d; gavage) over the course of 2 generations on growth and behavioral, neurological, neuropathology in offspring, and of oral TBBPA (0, 100, 300 or 1000 mg/kg bw/d; gavage) on embryonic/fetal development from gestation days (GDs) 0 to 19. In the reproductive study, exposure to & #8805; 100-mg/kg bw/d TBBPA resulted in changes in the peripheral thyroid levels in rats that were explainable on the basis of induction of liver catalobism, a nonhuman-relevant phenomenon. TBBPA at up to 1000 mg/kg bw/d was not associated with any significant non-neurological effects on reproduction, growth and development. A subtle reduction, of unknown biological relevance, in the thickness of the parietal cortices of 11-day-old F2 pups from the 1000 mg/kg bw/d group was noted. However, this change was not accompanied by evidence of micro-anatomic change. No other test article-related effects on developmental neurotoxicity/neuropathology were present. In the developmental study no test article-related mortality was observed in any of the dams. Sporadic and non dose-related ptyalism in dams was associated with the administration of TBPPA at doses of & #8805; 300-mg/kg bw/d, which was regarded as being non-adverse. No other test article-related effects were observed. The NOEL for maternal and developmental toxicity was 1000 mg/kg bw/d, the highest dose evaluated.

Cancer screening programs are grounded in the belief that early detection is the best protection against dying of cancer. Emerging research is proving otherwise. When combined with early detection may sometimes outweigh the benefits. Governments and cancer agencies that have made policy changes incorporating this new evidence are finding that it is difficult to "unring the bell" on the message that "early detection is your best protection." Emerging risk communication research argues that affective responses— as opposed to analytical judgments—are a powerful influence on individuals' health care decision making, particularly affecting responses induced incidentally by factors beyond the control of policymakers (e.g., mass media, social media, advocacy and specialist organizations). Drawing from qualitative focus group data, this paper explores affective factors in the decision making of Canadian women and men about, respectively, mammogram screening for breast cancer and PSA screening for prostate cancer. Affective factors were a major influence in many participants' screening decisions, particularly in those most supportive of screening - women who felt mammogram screening should begin at age 40 rather than 50, and men who felt PSA screening should be expanded beyond its current unorganized, opportunistic usage. Their most compelling rationales were worry and fear about cancer and a general enthusiasm for the benefits of early detection, accompanied by a willingness to accept relatively substantial risks of experiencing screening harms (e.g., false-positives, over-diagnosis, over-treatment) in return for comparatively small and/or uncertain benefits. Men most supportive of prostate cancer screening acknowledged that the PSA test is unreliable but felt that the benefits are "worth the risk." Men also expressed affective concerns about gender inequity—that more resources and attention are devoted to women's cancers than to men's cancers. Policymakers attempting to communicate more nuanced versions of the "early detection" screening message need to understand the role of affect in laypersons' decision making.

Defining the range of the reference dose: imprecision versus uncertainty

Within the process of chemical risk assessment, risk characterization of non-cancer endpoints lacks an established method to account for the uncertainty associated with the value estimate of the non-cancer hazard. The lack of an established method to provide quantitative bounds on the uncertainty associated with non-cancer hazard estimates has been a considerable limitation upon effective risk communication and decision-making at waste cleanup sites since the implementation of environmental assessment and remediation programs (e.g., CERCLA, RCRA and state cleanup programs) over the past thirty-five years. The National Academy of Sciences (2009; p. 128) and NAS (2014, page 143) discuss the method to account for the uncertainties associated with a point estimate, and the most appropriate endpoint-specific ceiling value.

The non-cancer hazard range was judged to be 3 μg/m3 to 20 μg/m3. Of the nine values), the TCE non-cancer hazard range was judged to be 3 μg/m3 to 20 μg/m3.
decision making and anticipate how their messages will be shaped, transformed, and potentially subverted by external factors.

**T4-E.2 Duarte, HO; Droguett, EL*; Carvalho, F; Center for Risk Analysis and Environmental Modeling; heitorode@gmail.com**

**Ecological risk of the tuna fishing industry to a relevant shark population in the South Atlantic Ocean: a probabilistic model-based assessment**

Fishes represent the only major food still harvested from wild populations. Tuna and tuna-like products represent 8.7% of total global fish trade. Thousands of vessels in all oceans undertake tuna fishing. Most of the world’s catches of tuna are taken incidentally by various types of tuna fishing gear (e.g., longline), constituting bycatch that is either discarded at sea or landed for sale. Bycatch increases the extinction risk of several species of shark, altering ecosystem functions by removing top predators as well as causing socioeconomic damage by limiting tunas’ harvest. We quantify the ecological risk in the South Atlantic caused by this industry. We use the shortfin mako shark (SMA) (Isurus oxyrinchus) female population as bioindicator because it is one of the most dominant species bycaught. We build two models and integrate them: (i) a stock assessment model to estimate initial population abundance and (ii) a population model that describes the population abundance in the next 100 years under several harvest regimes. The integrated model is probabilistic in nature and considers uncertainty in parameters and initial conditions. We compare harvest scenarios against a no-harvest scenario and quantify the added risk. We evaluate: the added ecorisk estimates for each scenario (i.e., probability and time to population quasi-extinction, probability of 20% and 50% decline within 100 years and expected minimum abundance); the yield (i.e., the total weight of harvest for the 100 years simulation); and the risk of low harvest (i.e., the probability that the annual harvest will be at or below a threshold measure). We suggest risk categories for efficient risk communication of harvest scenarios. We also quantify the reduced ecorisk caused by a cutoff control measure established to satisfy conservation objectives. We finally suggest an optimum harvest regime to achieve maximal yield over the long term at acceptable ecorisk and risk of low harvest.

**P.21 Dube, EM, ED*; Sullivan, KS, KS; Brynczka, C, CB; Gradient; edube@gradientcorp.com**

**Study Design and Physiochemical Data Considerations for a Subacute Inhalation Study of a UVCB**

We developed physiochemical and toxicity data on a substance of unknown or variable composition, complex reaction product or biological material (UVCB), that is used solely in industrial operations. We determined the substance behaves like a poorly soluble particulate (PSP) based on its physiochemical data, gene and acute toxicity results, and repeat-dose inhalation study results. PSPs are not cytotoxic or genotoxic, and are non-reactive with biological tissues. Excessive exposure to PSPs via inhalation can overwhelm the clearance mechanism of the lung, causing a localized immune response due to its inability to adequately remove the substance. A repeat-dose inhalation toxicity study with a reproductive / developmental screening test was conducted for regulatory purposes to assess the systemic toxicity of the substance in the rat from inhalation exposure (the primary route of worker exposure), and to provide information on reproductive / developmental effects. While the results of the repeat-dose study showed no reproductive or developmental effects, there was a statistically significant increase in lung weight in both sexes at the high dose, and in WBC parameters in male rats only at the high and low doses. Females did not show the same WBC response as males, which may be an artifact of the study design. Because the test material was determined to be a PSP, we believe a reversible overload effect of the substance in the rat’s lung is the reason for the difference in WBC parameters between the male and female rats. This observation is supported by the published literature, and led to the conclusion that the substance has no inhalation hazards and does not need to be classified under GHS. We discuss the need for a recovery period in subacute repeat-dose studies, the importance of considering physiochemical data when assessing toxicity, and the significance of selecting appropriate dose levels to test in subacute inhalation toxicity studies.
Can policy be risk-based? A reality check based in the cultural theory of risk.

Calls for a foundational shift in approaches to socio-technical hazards are commonplace. What is needed, the argument goes, is ‘risk-based’ policy rather than politically muddled, event driven policy. And yet when pressed, many experts often acknowledge both inevitability and significant value in the prevailing political basis of policy. This paper both evidences this contradiction through qualitative interviews containing explicit examples, and offers an explanation through a cultural theory of risk (or CT) lens. Our data concerns livestock disease containment, a prominent area of risk management in recent years. Livestock disease management provides a topical space in which views regarding interactions between risk and society can be explored. CT advocates a society in which policy directed at hazard management is highly politicised because this demonstrates a healthy, free debate on values (Douglas 1992). CT views quests for depoliticised, objective footings on which to found conceptions of risk, as the product of ‘methodological individualism’ that neglect culture yet appeal to ‘experts’ seeking to escape the messy, contested realities of the social world by bracketing them off, in preference for less troublesome, probabilistic approaches. Calls for a risk-base, from the CT perspective, are characterised as aligned with a positivist epistemological paradigm in which probabilistic thinking is wrongly viewed as a guarantor of objectivity, shielding society from the more irrational effects of interest-based politics. In fact, escape is impossible. Using the cultural theory of risk calls for risk-based policy are presented as rhetorical symbols acting as rallying points in battles for resources, drawing broad political support from interests concerned about an institutional void and masking a subversive scientism that acts to make other socially useful understandings invisible.

An Assessment of Prevalence-based Models for Predicting the Public-Health Effects of Microbial Food-Safety Policies

Risk assessment models are used for predicting the number of illnesses avoided as the result of new food-safety policies. These models depend on complex relationships between the distribution of contaminants that are available for sampling during production or processing, the distributions describing changes occurring between the initial sampling event and up to the time of consumption of the food, and a dose-response function that predicts the probability of illness given different dose levels. This analysis examines this relationship to determine the conditions under which a simple model – that predicts the change in illnesses as a linear function of the change in prevalence – is appropriate, conservative or too optimistic. Generally, we find that the “prevalence-based” method modestly under-predicts the expected reduction in illnesses associated with the implementation of a new policy across a range of measureable prevalence levels (realizing that observed prevalence is dependent on the limit of detection of an assay and the concentration of the pathogen in the sample). The method is shown to over-predict the expected reduction in illnesses if the prevalence is too low, which indicates that positive samples were derived from the extreme tail of the contamination distribution.
Perception of risk factors for cancer. A clear lesson from the Edifice Melanoma survey: Bad is Bad.

Cancer control requires the use of numerous tools and the commitment of countless players for implementing risk mitigation strategies based on health promotion rely on the lay population's knowledge and behavior. Melanoma is a peculiar cancer for which there is a preventable measure related to a single external risk factor: sun exposure. How the layperson perceives risk factors for such a clearly-defined condition may help to clarify the perception of risk in the population at large. A nationwide observational survey, EDIFICE melanoma, was conducted in France through phone interviews of a representative sample of 1,502 subjects aged ≥ 18 years old, using the quota method. The survey took place from 28 September 2011 to 20 October 2011. Questions focused on sun-exposure behavior, and knowledge about melanoma. Actual risk factors for melanoma (sun exposure, atypical nevus, personal history of melanoma, light phenotype, etc.) are relatively well-known and were quoted in our sample by 92% 78%, 70% and 68% of respondents, respectively. Interestingly however, behaviors such as tobacco or alcohol consumption that are unrelated to a higher risk of melanoma, were mentioned as increasing risk by a relatively high percentage of persons (38% and 24%, respectively). Even more surprising were the 22% who mentioned antiperspirants, as though a known (or believed) risk factor for one frequent cancer (lung or breast) may well be a risk factor for another cancer (melanoma). In contrast, in response to another question, only 4% agreed with the statement that sun exposure might decrease the risk of certain cancers, which is true, hinting at the lay population’s difficulty in accepting that a known risk factor for one cancer (melanoma) can be a protective factor for another. Conclusion: If sun exposure does indeed increase the risk for melanoma, it is therefore an "evil" factor which cannot be beneficial. The perception and classification of risk factors appears to be both holistic and Manichean.

Heavy Metals in Sections of the Nile River

Egypt is one of the countries facing great challenges due to its limited water resources represented mainly by its fixed share of the Nile water and its aridity as general characteristics. The Nile is considered a primary receptor of wastewater and irrigation return flow. During its transit through Egypt, the river receives numerous non-point and point source discharges. Nile water pollution with metals is considered to be one of the most important problems confronting human and animal health. The introduction of heavy metals into the aquatic environment and resulting effects is a major issue that gives rise to concerns at local, national, regional and global scales. Despite extensive studies on Nile River, most of the comprehensive record concerning water Nile pollution is from a survey conducted long time ago. The concentrations of different heavy metals (Cd, Pb, Cu, Ni and Zn) in water, fish, plants and sediments were recently determined at different ten stations throughout the Nile River at Great Cairo region to assess the extent of contamination in these areas. The recorded data reflect the presence of these metals in the surrounding forage and soil and thus, give some information about the heavy metals pollution in these regions. The present study also, discusses the Nile water issue in terms of heavy metals water pollution problems in Egypt, water pollution control, management guidelines and protection monitoring programs. All of these goals aimed to accelerate the process of purification which nowadays is the main objectives of Egyptian economy.
**T2-I.4** Esposito, PA; Newberry, J; Daigle, KJ; Woodhull, D*; American Society of Safety Engineers, Risk Assessment Institute; dee.woodhull@orchse.com

**Risk Communication Challenges at the Executive Level—Effective Use of Data**

This session discusses a study that focused on determining the relationship between injury and illness data and the likelihood that future incidents can be predicted from them and prevented. Perception of risks by senior corporate executives is driven by their understanding of the data communicated to them. This in turn drives decision making with respect to mitigation. Risk communication must be based on information that enables the recipients to correctly understand potential risks and respond appropriately. A common practice for risk identification in occupational settings has been to rely on previous injury experience, assuming that the frequency of incidents related to specific equipment, processes, or machinery is an appropriate indicator. Research has revealed that such data can be used to identify risks with respect to non-serious injuries—those that are not likely to be fatal, life-threatening, or life-altering. Fatal or serious risk, however, cannot be identified in this manner because injury and illness data do not predict these events. The session will present a company example of how communicating this information to its executive leadership led to changes in perception of what constituted risk and drove action to abate. At the end of the symposium session, we will reserve 15 minutes for Questions and Answers. Audience members will be able to ask questions regarding each of the presentations, as well as ask questions in a round table format such that each of the presentations, as well as ask questions in a round table format such that each of the speakers will provide comments, as appropriate.

**T2-I.1** Esposito, Paul A, PAE; American Society of Safety Engineers; paul.esposito@starconsultants.net

**Risk Assessment Communication Challenges at the Organizational Level**

This is part of Symposium on Communication Challenges in the Occupational Settings. Within an R&D organization of about 3000 people, accident rates have been flat for a number of years. In breaking down the data, looking at the more severe incidents (lost time) as well as frequency, causation seemed to be random. Step 1 was to change the causation model. Once the results were tabulated, there were three critical causal factors that became apparent. The number one cause was the inefficiency of the planning process; hazard analysis (risk assessment) in particular. The number two and three causal factors was interrelated; part of the Management System Check and Act. There was a lack of accountability on the part of the organization to develop leading metrics and there was no accountability for management to resource or prioritize the closure of action items that resulted from incident investigations. Risk Assessment became the new strategic plan. Existing risk matrices were researched, from Mil Std 882D, to ANSI B11TR3 and ANSI Z10. There was good stratification and quantification at the severity risk factor, but scant detail in likelihood. The methodology chosen was a checklist approach, tailored to the hazard categories as identified in OSHA’s Publication 3017, Hazard Analysis, as modified to the categories inherent to the organization’s regulatory register. To address the accountability issue, the following scorecard model chosen. Did you complete your risk assessment? Did your organization identify the top 2 - 3 risks that needed to improve? Did department management take ownership of these targets? Were Action plans tracked? Was there conformance to critical controls? Each of the above will be described in detail, as well as lessons learned.

**M4-I.1** Esswein, EJ*; Snawder, JE; King , B; Breitenstein, M; Alexander-Scott, M; Kiefer, M; National Institute for Occupational Safety and Health (NIOSH); ejel@cdc.gov

**Hiding in Plain Sight: Analyzing a Significant, yet Previously Unidentified Workplace Exposure Risk during Hydraulic Fracturing.**

Unconventional oil and gas extraction (directional drilling coupled with high-volume hydraulic fracturing) continues to increase in scale in the U.S. not only in established basins but also in newly identified areas of hydrocarbon reserves. While risks for worker fatalities and injuries in oil and gas extraction are known, published studies of risks for chemical exposures are lacking. In 2010, NIOSH initiated the Field Effort to Assess Chemical Exposures in Oil and Gas Workers to evaluate the scope and magnitude of risks for chemical exposures for workers during unconventional drilling, completions and well servicing operations. This presentation outlines a framework used for risk characterization in unconventional oil and gas extraction and explains results from a large study conducted at 11 sites in 5 states where exposure risks for respirable crystalline silica (a mineral commonly used during hydraulic fracturing) were evaluated. The multi-dimensional risks present in unconventional oil and gas extraction provides for myriad opportunities for chemical risk assessment; but exposure to respirable crystalline silica was chosen for 4 important reasons, each of which is vital to understand whenever risk analyses are conducted.

**DULPIC.** Esswein, EJ; NIOSH; ejel@cdc.gov

**Overview of Exposure Risks for Chemical and Mineral Exposures to Workers during Unconventional Oil and Gas Extraction especially Hydraulic Fracturing**

The National Institute for Occupational Safety and Health (NIOSH) has had an active program of occupational safety and health research in unconventional oil and gas extraction since 2005. The primary goal of program is reducing occupational diseases and injuries. Research is conducted through partnerships with industry that result in high quality outputs leading to practical solutions to limit exposures and Research-to-Practice (R2P) technology transfer outcomes. While risks for fatalities and injuries to oil and gas extraction workers have been described by NIOSH, risks for chemical exposures are less well established or described in the scientific literature. The NIOSH Field Effort to Access Chemical Exposures in Oil and Gas Workers was incepted in 2010 to address the need for rigorous exposure assessment science in oil and gas extraction and determine the scope and magnitude of exposure risks for a variety of chemical and mineral exposures for workers involved in drilling, completions and servicing operations. This presentation discusses risks for chemical and mineral (i.e., respirable crystalline silica) exposures during hydraulic fracturing and controls to limit or prevent workplace exposures.
M2-F.2 Esswein, E, NIOSH; ejel@cdc.gov  
Overview of Exposure Risks for Chemical and Mineral Exposures to Workers during Unconventional Oil and Gas Extraction especially Hydraulic Fracturing  
The National Institute for Occupational Safety and Health (NIOSH) has had an active program of occupational safety and health research in unconventional oil and gas extraction since 2005. The primary goal of program is reducing occupational diseases and injuries. Research is conducted through partnerships with industry that result in high quality outputs leading to practical solutions to limit exposures and Research-to-Practice (R2P) technology transfer outcomes. While risks for fatalities and injuries to oil and gas extraction workers have been described by NIOSH, risks for chemical exposures are less well established or described in the scientific literature. The NIOSH Field Effort to Access Chemical Exposures in Oil and Gas Workers was incepted in 2010 to address the need for rigorous exposure assessment science in oil and gas extraction and determine the scope and magnitude of exposure risks for a variety of chemical and mineral exposures for workers involved in drilling, completions and servicing operations. This presentation discusses risks for chemical and mineral (i.e., respirable crystalline silica) exposures during hydraulic fracturing and controls to limit or prevent workplace exposures.

T3-J.1 Evans, C; Colorado State University; caitlin.evans@colostate.edu  
Risk information seeking behavior and patient-provider interaction  
This paper proposes a new way of investigating risk information seeking behavior as it relates to the patient-provider communication interaction and, specifically, the communication surrounding nutrition. Health care providers are an underutilized resource for nutrition information. If scholars and medical professionals can analyze the patient-provider communication interaction in terms of relational stages, they might be able to point out cognitive processes that are influencing the interaction, when those processes are having the greatest impact and what providers can do to help foster better communication. The first proposed theoretical step would be to create a modified relational stages model that can be applied to the patient-provider interaction. One of the most highly cited models of development today is Knapp’s (1978) relational stage model. It would seem reasonable to use this model as a basis for the patient-provider stages model. Griffin, Dunwoody, and Neuwirth (1999) proposed a model of Risk Information Seeking and Processing to understand individual responses to messages about health risks. The RISP model includes motivations, multiple characteristics, and channel beliefs to predict the information seeking and processing behaviors of individuals when confronted with a health risk. This type of investigation could provide practical advice and strategies for patients when dealing with patients and nutrition. Here I propose a need to investigate the cognitive processes at each stage of relational development as a way to find practical solutions for providers to optimize quality communication interactions with patients. By combining relational stages and risk communication, scholars might gain further insight into this dyadic communication exchange and assist providers in communication strategies or tactics to improve patient health.

T4-I.5 Evans, AM; Rice, GE; Wright, JM; AME: Oak Ridge Institute of Science and Education; GER and JMW: US Environmental Protection Agency; evans.amandam@epa.gov  
Assessing Nonchemical factors in Cumulative Risk Assessment (CRA): A Case Study of the Association between Lower Heart Rate Variability and Particulate Matter  
There has been increased interest in the integration of chemicals (e.g. particulate matter, lead) and nonchemicals (e.g. genetics, gender, lifestyle) in cumulative risk assessment (CRA). Because few toxicological or epidemiological studies on these complex mixtures have been conducted, determination of potential hazard is difficult. CRAs will often need to combine information from disparate sources to assess more realistic mixtures of chemicals and nonchemicals that are of interest to governments and communities. Therefore, methods are needed to help identify and prioritize chemicals and nonchemicals for inclusion in CRAs. Additionally, case studies utilizing these proposed methods should be carried out to determine their utility. In some populations, particulate matter (PM) has been associated with lower heart rate variability (HRV) and lower HRV has been associated with an increased risk for cardiovascular disease. Using a recent meta-analysis, and associated studies, on the association between lower HRV and PM, this presentation will outline how to identify and prioritize additional chemicals and nonchemicals that may modify the association between lower HRV and PM for inclusion in a hypothetical CRA. Conceptual maps for lower HRV will be presented and their utility for identifying chemicals and nonchemicals as potentially modifying factors or confounders discussed. The views expressed herein are those of the authors and do not necessarily reflect the views or policies of the U.S. Environmental Protection Agency.

M2-K.1 Evensen, D*; Stedman, R; Cornell University; dte6@cornell.edu  
Communicating risks and benefits of shale gas development (“fracking”)  
Shale gas extraction and development via hydraulic fracturing (often called “fracking”) is an extremely contentious energy development topic, and a highly discussed and contested political issue throughout North America and Europe. Much public discourse about “fracking” has focused on negative environmental risks and positive economic benefits. This simplistic image of environment vs. economics and clear risks vs. clear benefits, however, is misleading. We present results from fifty in-depth interviews (from the states of New York and Pennsylvania and the Canadian province of New Brunswick) and a survey of randomly-sampled residents from the Marcellus Shale region in NY and PA (n=1200) that reveal the importance of social impacts. These social impacts are often difficult to quantify and are viewed as both positive and negative. The interviews and survey also reveal the relevance of ethical considerations to evaluations of shale gas development. Further complicating discussion of this topic and its risks and benefits are our results from three surveys (i.e., the previously mentioned survey, a random-sample survey of NY residents [n=800], and a survey of a random USA sample [n=1000]) that reveal stark differences in representations of shale gas development/fracking across geographic contexts. We conclude with recommendations for ways to discuss this contentious issue that avoid some of the inherent polarization. We suggest ways to more directly address the root causes behind perceptions of risk and benefit.
Factors affecting propensity to follow government advice in a flu outbreak

Based on a survey of a stratified six-nation European sample \( n=5,648 \), we enumerate and describe the factors that best predict an individual’s propensity to follow government advice on taking antivirals during a flu outbreak. The propensity to follow government advice is an important public health question. Additionally, if governments spend large sums of money to stockpile antivirals, the governments need to understand the extent to which people would take these antivirals at the government’s behest. The strongest predictors of following government advice are: (1) one’s belief about whether or not more information about medicine safety would increase his/her confidence in taking the medicine, and (2) several direct and indirect measures of trust. Explicit trust variables in the survey measure the degree to which respondents find their national health agency and the pharmaceutical industry to be trustworthy. Indirect measures of trust assessed respondents’ perceptions of the effectiveness of their national government and national health agency at providing members of the general public with medical information. Perceptions of government support for the pharmaceutical industry were a particularly strong predictor of not following government advice. We present several structural equation models that highlight the relationships between the aforementioned variables. We offer separate models for propensity to follow government advice about “swine” (H1N1) influenza and “avian” (H5N1, H7N1) influenza. We also examine nation-specific models. We conclude by discussing implications for government health policy and health communication in Europe.

As an issue fraught with scientific uncertainties and plagued with social complexities, climate change risk can be interpreted and framed from different perspectives in policy discourse. How risk is framed has an impact on policy agenda setting and thus policy making. However, the framing of climate change risk is meagerly studied, especially in China where policy making is usually regarded to be opaque and mysterious. This study is designed to explore how climate change risk has been framed in China’s policy discourse with media content analysis. Articles mentioning climate change explicitly are extracted from 1946 to 2013. Content analysis is utilized to analyze how climate change has been discussed and interpreted in these years. Human coding method is used first to develop a coding scheme based on random samples from the database which is comprised of more than 4000 articles. Then supervised learning method is employed to analyze the article population to identify the framework in defining climate change risk. The results are expected to show the framing evolution of climate change risk as well as the development of relationships between climate change and other policy issues in the past decades. Finally, this study concludes with discussion on the propensity and influential factors of China’s policy discourse in framing and reframing climate change risks.

The outbreak of the toxic capsule crisis during April 2012 aroused widespread public concern about the risk of chromium-contaminated capsules and drug safety in China. In this paper, we develop a conceptual model to investigate risk perceptions of the pharmaceutical drug capsules and behavioral responses to the toxic capsule crisis and the relationship between associated factors and these two variables. An online survey was conducted to test the model, including questions on the measures of perceived efficacy of the countermeasures, trust in the State FDA (Food and Drug Administration), trust in the pharmaceutical companies, trust in the pharmaceutical capsule producers, risk perception, concern, need for information, information seeking, and risk avoidance. In general, participants reported higher levels of risk perception, concern, and risk avoidance, and lower levels of trust in the three different stakeholders. The results from the structural equation modeling procedure suggest that perceived efficacy of the countermeasures is a predictor of each of the three trust variables; however, only trust in the State FDA has a dampening impact on risk perception. Both risk perception and information seeking are significant determinants of risk avoidance. Risk perception is also positively related to concern. Information seeking is positively related to both concern and need for information. The theoretical and policy implications are also discussed.
P.22 Fiebelkorn, SA*; Cunningham, FH; Dillon, D; Meredith, C; British American Tobacco, Group Research and Development, Southampton, SO15 8TL, UK; stacy_fiebelkorn@bat.com
Application of a Margin of Exposure approach to benzene, a tobacco smoke toxicant.
Benzene is a volatile chemical used in industry and present in petrol, exhaust fumes and tobacco smoke. Several epidemiological studies have shown an increased risk between occupational benzene exposure and increased leukaemia risk, in particular acute myeloid leukaemia (AML). Benzene is one of many chemicals that have been identified as a tobacco smoke toxicant, with smoking contributing up to 90% of an individual’s exposure. We have previously used Margin of Exposure (MOE) calculations to segregate tobacco smoke toxicants into high and low priority for risk management action, using guidelines developed by the European Food Safety Authority (EFSA). An MOE greater than 10,000 can be considered a low priority for risk management actions. Here, the approach has been extended to incorporate the epidemiological data available for benzene and leukaemia risk. An estimate of the daily dose corresponding to a 1% additional lifetime risk over the background risk (TD1) has been used as the point of departure (PoD). Occupational study meta-analyses were used to generate potency estimates and TD1 values, and a machine smoked yield for a 3R4F reference cigarette used to estimate human exposure. The resulting MOEs calculated for leukaemia and AML endpoints range from 16 to 36. These are all lower than 10,000 and indicate that benzene is a high priority for exposure reduction research. This is our first application of the MOE approach utilising epidemiological data. Previous MOE assessments have utilised experimental animal data to generate a PoD, in these cases an uncertainty factor of 10 has been incorporated into the 10,000 critical value, for inter-species extrapolation. The use of human data removes this uncertainty and there may be a case to adjust the critical value to 1,000 when utilising epidemiological data. Further refinement of this approach would be recommended through the investigation of alternative PoDs, use of mode of action reviews and the application to additional tobacco smoke toxicants, where epidemiological data is available.

W3-E.1 Finkel, AM*; Maynard, A; Bowman, D; Trump, B; University of Pennsylvania Law School; University of Michigan School of Public Health; afinkel@law.upenn.edu
Channeling Synthetic Biology through “Solution-Focused Risk Assessment”
Experts in quantitative risk assessment have in the past several years made some progress describing the many possible adverse consequences of emerging applications and emerging field of synthetic biology (SynBio). Few analyses, however, have attempted to estimate the probabilities or severities of these potential harms. As this work progresses, it will be crucially important to conduct a sensible weighing of risks, benefits, and alternatives. In a recent National Academy of Sciences report and a subsequent article, I have proposed turning the 1983 NAS “Red Book” risk management paradigm on its head. For example, applied to the problem of bisphenol A (BPA) in plastic water bottles, the “Red Book” approach could result in an exposure limit for BPA, while a more expansive life-cycle approach could involve a discussion of the comparative risks of different plasticizers. In contrast, a “solution-focused” approach would start by reminding us what we are trying to do in the first place—here, seeking to give consumers ready access to cold drinking water—and this might prompt discussion about how we might help “nudge” the market back to the day when Americans weren’t trucking 29 billion bottles of water to and fro every year, and throwing most of them into the ground soon after using them. Applied to SynBio, “solution-focused risk assessment” could involve a discussion of the value of a decommissioning approach to a high priority for exposure reduction research. In this framework, society could look first to each human need that a SynBio application promises to fulfill, and consider what might and might not tolerate novel risk in proportion to the unique benefit that the SynBio product/process offers. This presentation will introduce six case studies of a solution-focused approach to specific SynBio applications. Cases include ethanol production using algae, modified intestinal flora to reduce the infectivity of cholera, engineered mosquitoes to prevent dengue fever, and bio-isoprene synthesis.

M3-I.1 Finkel, AM; University of Pennsylvania Law School; afinkel@law.upenn.edu
A structured plan for seeking consensus on inference options for occupational risk assessment
In a recent SRA Annual Meeting presentation, I emphasized that the needed work of generating approximately 200 risk-based occupational exposure limits (RB-OELs), for the carcinogenic and toxic substances being managed by agencies of importance, would not require much time or money—especially compared to the time already spent not developing these kinds of benchmarks. A small group of expert risk assessors could do this work expeditiously, but under “ground rules” for quantifying risk that only their professional judgment suggested were sensible. It would be preferable to implement a two-phase process, wherein stakeholders with training in risk assessment first participated in the hard work of seeking a broader consensus about what these ground rules should be—with the goal of either agreeing on them, or agreeing to disagree and presenting more than one set of RB-OELs reflecting that lack of consensus. Here I will present a structured overview of the various science-policy choices that must be confronted—including the selection of one or more animal or human studies, the selection of a dose-response model or models, the assignment of reference parameters for animals and humans, the quantification of human interindividual variation, and the evidentiary standard necessary to supplant one or more of the generic default inferences with a substance-specific alternative, when appropriate. Throughout the discussion, I will emphasize the differences—usually in the direction of less ambiguity and controversy—important in estimating risk in the occupational setting, where extrapolation beyond factor effects is always less heroic than in environmental risk assessment, and sometimes not needed at all.

W1-B.2 Fischbach, JR*; Johnson, DR; Groves, DG; Sharon, C; RAND Corporation; jordan_fischbach@rand.org
Flood risk reduction benefits and costs in Louisiana’s 2012 Coastal Master Plan
Louisiana’s 2012 Coastal Master Plan identifies $50 billion in investments to address the primary goals of coastal land building and flood risk reduction. To develop the plan, the state applied a series of integrated systems models to evaluate future coastal conditions and estimate potential benefits from proposed risk reduction and restoration projects. This information was used to identify the projects that would best meet the state’s goals while accounting for uncertainties in future environmental conditions. The master plan analysis identified sets of projects that would maximize these benefits in the near-term (year 20) and in the long-term (year 50) given budgetary and other constraints. In this analysis, we built on this initial evaluation by applying benefit-cost analysis to estimate the net economic benefit from projects in the plan identified specifically to reduce future flood risk ($21 billion of the total $50 billion investment). We consider a range of uncertain environmental factors and planning conditions, including sea level rise, coastal subsidence, economic growth rate, project costs, and discount rate. We use the master plan analysis and Coastal Louisiana Risk Assessment (CLARA) model to estimate risk reduction benefits from proposed projects 0, 25, and 50 years into the future, and apply additional assumptions regarding investment timing to estimate benefits in the intervening years. Results suggest that the proposed risk reduction projects yield positive net present value across a wide range of assumptions. Net benefit over 50 years is higher under more adverse sea level rise and coastal subsidence scenarios. Only a combination of high project costs and high discount rate assumptions leads to zero or negative net benefits.
Lifestage physiologically-based pharmacokinetic models PBPK model-based predictions provide risk assessment methodology to interpret human biomonitoring literature and to perform internal margin-of-exposure comparisons for interspecies extrapolation. To better understand the pharmacokinetics of ingested BPA across laboratory animals and humans, low dose pharmacokinetic studies were conducted with deuterated bisphenol A (BPA). Physiologically based pharmacokinetic models have been developed for rats and humans to better predict human internal exposure to unconjugated BPA when BPA is ingested as a food contaminant.

EPA's Framework for Human Health Risk Assessment to Inform Decision Making

The Framework for Human Health Risk Assessment to Inform Decision Making was developed by EPA's Risk Assessment Forum to be responsive to the decision-making needs of the Agency. It addresses the recommendations presented in the National Research Council’s Science and Decisions (2009) on the design of risk assessments, including planning, scoping, and problem formulation. The Agency’s Risk Assessment Forum held broad based internal discussions prior to assembling a Technical Panel of senior risk assessors from across the Agency to develop the Framework. The Framework received extensive Agency review along with inter-agency and external peer reviews. In developing the final Framework the input from the review process along those received from the public were considered. In addition to the focus on planning, scoping and problem formulation, the Framework presents the concept of risk assessment that are “fit for purpose” and details that this is accomplished with an increased dialogue between risk assessors and decision makers to ensure that the risk assessment will inform the risk management options. The problem formulation phase described in the Framework emphasizes the development of a conceptual model that follows the source to outcome continuum for the risk assessment as a key input into the development of the analysis plan. In accordance with longstanding agency policy, it also emphasizes the importance of scientific review and public, stakeholder and community involvement and links the reader to agency resources on these topics. This Framework will facilitate implementation of existing and future EPA guidance for conducting human health risk assessments and in improving the utility of risk assessments that inform the decision-making processes. This presentation will highlight details of the Framework.

EPA's Framework Presenter Discussion Panel

Panel Discussion with Symposium presenters and audience.

Case studies: different risk assessments and lessons learned from interactions

As the importance of food safety risk assessment continues to grow in support of decision-making for policy development, challenges remain in conducting and managing risk assessment to fully engage risk managers and stakeholders in the process. The choice of the specific approach to be used for a risk assessment depends on the specific questions to be addressed, the availability of data, methods, and the timeframe. Risk assessments undertaken by FDA span the range of qualitative, semi-quantitative and quantitative methods, which are designed to address a wide range of risk management questions on estimating risks and impact of interventions on the risks from chemical and microbial hazards in foods. Case studies will be presented, by each of the four authors, to highlight interactions among assessors, managers and stakeholders and lessons learned from different risk assessments, quantitative or qualitative, as follows: 1) arsenic risk assessment with an emphasis on interactions with risk managers, 2) pathogen (including Salmonella) in spices risk profile, with an emphasis on interactions with industry stakeholders, 3) drug residues in milk with an emphasis on refining the risk management questions, and 4) L. monocytogenes in soft-ripened cheese with an emphasis on collaborations with another country and response to public comments. The panel of speakers will share their experiences, in the context of the four specific risk assessments, challenges and lessons learned on how to address issues such as barriers to generating the right risk management questions (sufficiently risk specific), and engaging risk managers and constituents (stakeholders) to understand the scope of a risk assessment and the degree of uncertainty in risk estimates. [40 minutes total]
Many of the methodologies used today in the traditional approach to toxicology testing originated over half a century ago and current reliance on high-dose animal studies and the application of default extrapolation procedures leaves considerable uncertainty in human health risk assessment. Further these approaches are time-consuming, low throughput, costly on both the economic level and in requiring animal use and often offer limited mechanistic information about how the tested chemical or product will act in the human body, or in humans of diverse or at risk genetic backgrounds. Advances in toxicology testing such as systems biology, stem cells, engineered tissues, computerized modeling create unique opportunities to transform this predictive science to bring needed products to people faster and more safely and replace, reduce and/or refine animal testing. However, there are roadblocks to progress including reluctance to incorporate new technology into regulatory practice. There are many reasons for this, including lack of strong incentives, scientific uncertainties, a long history of generally successful use with traditional animal testing methods, under-confidence in non-animal methods and challenges to qualifying these new technologies for use in regulatory framework. This presentation will consider how these roadblocks can begin to be overcome at FDA which is committed to be an active participant in development of new methods and approaches through dialogue and collaboration among all stakeholders, including FDA, other regulators, NGOs, academics, & industry and proactively managing a growing portfolio of cross-cutting chemical and toxicology issues and to enhance scientific and policy communication, collaboration and training across FDA and with its external partners.

Studies to understand potential effects of hydraulic fracturing on human health and the environment are currently being done at the state and federal levels, however, none have included a human health risk assessment. We have undertaken a human health risk evaluation, specifically focusing on potential risks to drinking water in basins underlain by shale and other tight oil- and gas-bearing formations. Potential risks are evaluated for accidental surface spills and their impact on surface water or groundwater and potential leakage from the target formation upward through bedrock and into an overlying drinking water aquifer. Our approach uses a probabilistic (Monte Carlo) framework to assess the likelihood of releases and chemical transport. This analysis considers a broad range of environmental settings (e.g., soil thickness/permeability, distance to drinking water wells, accidental spill volumes), thus providing some much-needed perspective on the overall plausibility of the migration scenarios and associated risks.
Enhanced Adaptive Management: Methods and Application for Natural Resource and Environmental Projects

Uncertainties about future conditions and the effects of chosen actions, as well as increasing resource scarcity, have been driving forces in the utilization of adaptive management strategies. US Army Corps of Engineers, for example, requires the use of Adaptive Management in planning medium and large scale projects. However, many applications of adaptive management have been criticized for a number of shortcomings. To address these, we supplement existing adaptive management approaches with a decision-analytical approach that first informs initial selection of management alternatives and then allows for periodic re-evaluation or phased implementation of management alternatives based on monitoring information and incorporation of stakeholder values. We illustrate the use of this enhanced adaptive management (EAM) framework in two case studies: to analyze remedial alternatives at a mercury contaminated river, based on an understanding of the loading and behavior of mercury in the South River near Waynesboro, VA and to address restoration of Everglades utilizing uncertain future climate and performance of water management alternatives. The results show that the ranking of management alternatives is highly influenced by the relative importance placed on different objectives, by uncertainty in environmental model, and by cost estimates. The process itself demonstrates that a decision model can link project objectives, decision-maker preferences, environmental models, and short- and long-term monitoring information with management choices to help shape a management approach that provides useful information for adaptive, incremental implementation.

Technique for the Assessment of Intervention Options (TAIO)

The Technique for the Assessment of Intervention Options (TAIO) process uses a risk-weighted benefit-cost analysis approach to evaluate potential intervention options for dealing with animal health events. The TAIO process integrates risk analysis and benefit-cost analysis methods into a single analysis process. There are five basic analytical components to the TAIO process: (1) Disease agent pathway control, (2) Disease agent host response, (3) Logistic feasibility, (4) Benefits, and (5) Costs. The Benefits component of the process is where disease spread analysis and economic analysis interact most directly. Benefits are considered in terms of averted biological and economic consequences; both trade and non-trade-related. Determinations of the level of aversion are based in part on, for example, estimated changes in epidemic curves resulting from implementing proposed intervention options. Changes in potential economic consequences can then be estimated from the estimated changes in the epidemic curves.

Use of the Framework for Human Health Risk Assessment by EPA’s Waste and Cleanup Programs.

The Framework for Human Health Risk Assessment to Inform Decision Making was largely developed in response to recommendations in Science and Decisions (NCR, 2008), but it also builds upon many existing EPA practices. In general, the risk assessments conducted by EPA’s waste and cleanup programs are highly fit for purpose and feature problem formulation, use of conceptual models, stakeholder involvement, and other elements of the Framework. This presentation will review the current risk assessment practices by EPA’s waste and cleanup programs that are in alignment with the Framework, and identify potential opportunities for enhancements.

Shaping 21st-Century Science to Support Risk Assessment and Inform Regulatory Decision-Making

This introduction will describe the promise of the 21st Century Vision for Toxicology and the many challenges facing realization of its full potential with special emphasis on the non-biological aspects (e.g., political, economic, bureaucratic). It will introduce the speakers in this session highlighting what needs to be done to effectively integrate science with the other key, non-scientific, inputs that need to be considered in decision making to help build an Tox 21 risk assessment paradigm that will be readily accepted, thus allowing the more informative and efficient in vitro and computer modeling approaches forward as rapidly as possible.
W1-G.4 Fox, MA*; Baksh, S; Lam, J; Johns Hopkins University; mfox@jhsph.edu
Case studies of acceptable risk: paving the way for the risk-specific dose

The 2009 Science and Decisions report (the “Silver Book”), recommended developing risk-specific doses for non-cancer outcomes rather than the conventional Reference Dose/Concentration approach. The main arguments for this change were to allow analysis of benefits, costs and risk-risk tradeoffs of environmental decisions for non-cancer outcomes and to make better use of available science. The Silver Book proposed methods for developing risk-specific doses and briefly discussed how they could be applied. A key issue in applying these methods is the uncertainty and management is determining what is considered an acceptable or de minimis risk for the outcome of concern. Lacking an understanding of acceptable risk for non-cancer outcomes represents a major impediment to implementing Silver Book recommendations and to advancing the utility of risk science for policy making. To illustrate the problem, we looked at the dose-response information for the Hazardous Air Pollutants (HAPs) included in the 2005 National Air Toxics Assessment. Fifty-five (30%) HAPs had only a Reference Concentration and no risk-specific dose for cancer. Decision makers looking to reduce levels of these HAPs have no way to gauge health impacts, costs or benefits of policy proposals. A great deal of work lies ahead to develop risk-specific doses and acceptable risk guidelines for non-cancer outcomes associated with these HAPs and many other chemicals of regulatory concern. This project contributes to the effort by reviewing current examples of acceptable risk, such as the range of acceptable risk for carcinogens and the National Ambient Air Quality Standards, to identify the key issues and information that have been considered in understanding acceptable risk for decision-making to date. The results will inform a framework for developing acceptable risk guidelines as risk-specific doses become available for non-cancer health outcomes under the unified approach to dose-response.

W2-J.3 Friedman, SM*; Egolf, BP; Lehigh University; smf6@lehigh.edu
Earthquake Risk Perceptions in a U.S. East Coast Urban Area

Most residents of highly seismic areas such as California are aware of earthquake dangers and the need for preparedness. Whether residents of the mid-Atlantic region are similarly aware and prepared is questionable. The region has a long history of seismicity and in 2011 had the potential to generate moderate to large earthquakes. One recent example occurred in August 2011 in Mineral, VA., when a 5.8 magnitude earthquake caused moderately heavy damage to homes, schools, and critical infrastructure, and closed the Washington Monument for repairs for two years. Reports of ground shaking from this earthquake extended from Georgia to Montreal and west to Detroit and Chicago. Had this earthquake occurred closer to major East Coast cities, the potential for damage and the social and economic impacts would have been much greater. Lack of public awareness and preparedness could make such impacts even worse. To increase understanding of perceptions about earthquake risks in an East Coast urban area, this study conducted a random telephone survey of 401 people living in and around the Philadelphia region. In addition to focusing on risk perceptions about a possible earthquake and the damage it could cause, the survey also determined the respondents’ levels of knowledge about how to protect themselves during an earthquake, and which emergency alert, mass and social media communication sources they would use immediately after an earthquake, as well as the type of information they would be seeking. It also surveyed the levels of trust they had in information sources such as federal, state, and local governments, emergency and first responders, and nonprofit organizations. Comparisons of risk perceptions for five natural hazards, including earthquakes, were examined from both a risk and agenda-setting perspective. Risk perceptions also were evaluated in light of previous earthquake experience, education, gender, age, race and income.

M4-D.3 Frye, FEH; The MITRE Corporation; effrye@mitre.org
Surfacing Risk in the Internet of Everything

The migration toward an Internet of Everything offers great promise for enhancing quality of life and processing speed. On the other hand, an environment of exponentially greater connectivity is also an environment of exponentially greater risk. Work has begun in both industry and government to grapple with the increasing risk posed by the Internet of Everything. This presentation will briefly summarize the state of play in those efforts, and offer forward-leaning considerations for addressing omni-connectivity.

M4-J.2 Galizzi, M*; Tempesti, T; University of Massachusetts Lowell; monica_galizzi@uml.edu
Workers’ perceptions of risk and occupational injuries

This study explores the relationship between individuals’ risk tolerance and occupational injuries. We analyze data from the National Longitudinal Survey of Youth 1979, a national representative survey of U.S. workers which includes information about injuries, risk tolerance, cognitive and non-cognitive attributes, and risky behaviors. These data allow us to compare injured with uninjured workers. We measure risk tolerance through questions regarding individuals’ willingness to gamble on their life-time income. We estimate zero-inflated count models to assess the role played by such measures on workers’ recurrent injuries. Finally, we discuss several recommendations for occupational safety policies. To the best of our knowledge, no other studies have explored the potential relationship between the phenomenon of recurrent occupational injuries and individual propensity toward risk. Our results highlight the concurrent and changing role played by individual, work and environmental factors in explaining recurrent accidents. They show that risk tolerance and cognitive abilities affect recurrent injuries, although not always in the direction that proponents of the concept of proneness would expect. Our measure of risk preferences show that individuals who are somewhat more risk prone have fewer recurrent injuries than those who are risk averse. But the relationship is not monotonic and, therefore, not easy to predict. Furthermore, some variables play a different role in affecting the probability of any first injury as opposed to the probability of further injuries. This suggests that the experience of a first injury is worth changing even though safety consciousness. At the same time, we find that individuals’ “revealed risky preferences” - specific risky behaviors - are related to higher injury probabilities. Demanding working conditions, measures of socio-economic status, health, and safety problems experienced by workers during their youth, remain among the most important factors explaining the phenomena of recurrent injuries.

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These new tools are configured to model exposure to soil, sediment, fish, tap water, ground water, air, produce, and livestock contamination for chronic, sub-chronic, and carcinogenic endpoints. Baseline exposure assumptions are fitted with an appropriate chemical subset/picklist approach to analyze possible contaminants identified in the HF process, as well as options to add-to or subtract-from for ease of use. These new tools will be useful for concerned citizens, site-specific data for later modification. Output includes toxicity and save his/her site-specific exposure parameters, chemical parameters and toxicity values in a user file for future use. Once the results are obtained, they can be saved along with the site-specific data for later modification. Output includes toxicity metadata. These new tools will be useful for concerned citizens, risk assessors and risk managers.

Engineered nanoparticles or ultrafine particles—categorically defined as those particles with one dimension less than 100 nm—can, when inhaled, induce toxic responses beyond that expected for larger particles of the same substance. This evidence has led the National Institutes of Occupational Safety and Health (NIOSH) to recommend new exposure limits for particulates collected. However, a complete understanding of the risk and the demonstration of compliance with exposure limits for nanomaterials requires more detailed information. Therefore, demonstrating compliance with these recommendations (and potential future regulations) in actual workplace environments may be challenging given the complex mixture of engineered and inadvertently created nanoparticles present in the ambient air at a given point in time. Previous research in workplaces has either measured the total mass concentration of ultrfine particles, the total ultrfine particle count, or the fractional elemental composition of all ultrfine particulates collected. However, a complete understanding of the risk and the demonstration of compliance with exposure limits for nanomaterials requires more detailed information. Through sampling of ambient workplace atmospheres where engineered nanomaterials are not used, but ultrfine particles are expected to be present, this project evaluates the capability of combined analytical techniques including electron microscopy, x-ray spectroscopy, and computerized image processing to reveal the size distribution within the nano-scale range for each specific constituent (e.g., carbon, silica, iron) of the total ultrfine particle mixture in a realistic environment. The results of this project have implications for the feasibility of nanoparticle exposure regulations, and more realistic toxicity testing in animals.
Proposed methods for assessing green space and neighborhood indicators as influential factors for childhood respiratory health in the CCAAP study.

Exposure to traffic-related air pollution (TRAP) is a risk factor for childhood respiratory health. Health benefits or risks of green space, defined as open land covered with vegetation, have not been thoroughly examined. While public health benefits of green spaces have been reported for children's general wellbeing, few studies have examined potential interactions between green space and TRAP with inconclusive results. We investigate the incorporation of green space measures into analyses of TRAP exposure and potential health impacts using data from the Cincinnati Childhood Allergy and Air Pollution Study (CCAAPS), an ongoing prospective birth cohort study of children’s respiratory health. CCAAPS has applied proximity analysis, air monitoring, and land use regression to estimate TRAP exposures for study participants, who were categorized as exposed or unexposed to TRAP based on home address proximity to major highways or interstates. The study’s spatial design allows for detailed analyses of residential environments between different neighborhoods and potential environmental exposures. We examine residential proximity to green space with vegetation cover data from the Normalized Difference Vegetation Index. We are pursuing small-scale resolution data for municipal street tree cover and green space, including parks, greenways, and trails. We will review existing approaches for estimating green space and discuss methods currently under development for indexing both environmental quality using green space data and socioeconomic status using US Census data. We also discuss analytic approaches for incorporating green space and other neighborhood-level factors into environmental health risk assessments such as buffer analysis and land use regression. Results will inform methods for evaluating localized environmental health risks to children. The views expressed in this abstract are those of the authors and do not necessarily reflect the views or policies of the US EPA.

Representing expert judgments about climate damages using imprecise probabilities

One of the most important and uncertain considerations in the analysis of climate policy is how climate change will impact human health, the economy, and the environment. Expert elicitation, in the form of subjective probability distributions, is a useful means for synthesizing the diversity of empirical and model-based evidence on the magnitude of such damages. Thus far, only one large-scale elicitation of climate damages has been conducted. In 1994, William Nordhaus reported the results of an elicitation of 19 experts, who were asked to provide probability estimates of various levels of reduction in global economic output conditional on specific global mean temperature change scenarios. As understanding of the potential for climate damage has evolved in the 20 years since the Nordhaus survey, we recently undertook an effort to re-assess expert beliefs. One of the key aspects of our methodology has been to allow the experts to more openly express deep uncertainty or ambiguity in their beliefs using imprecise probabilities. In particular, we used the Density Ratio Class, which has many desirable features, including invariance under (i) Bayesian inference, (ii) marginalization, and (iii) propagation through deterministic models. These invariance properties are valuable because they make it possible to describe sequential learning and prediction under a unified framework. We describe numerical algorithms that exploit these properties to minimize the added computational burden relative to the use of precise probability distributions, and employ the algorithms to summarize the results from our climate damage elicitation.
M2-B.2 Gilmore, EA*; Calvin, KV; Green-Barnes, J; Hennig, R; Puett, R; Sapatka, A; Schwarber, A; University of Maryland; gilmore@umd.edu

Estimating the economic damages from temperature related human health effects in the US

Climate change is projected to increase the risks to human health. One pathway that may be particularly difficult to manage is adverse human health impacts from increases in mean temperatures and changing patterns of temperature extremes. Here, we develop estimates of economic damages from premature mortality from changing temperatures in the United States for each state to 2050 by extending the integrated assessment model (IAM), GCAM. First, we quantify the change in premature mortality. We identify a range of exposure-response relationships for temperature related mortality through a critical review of the literature. We then implement these relationships in the GCAM by coupling them with projections of future temperature patterns and population estimates. Finally, we evaluate how uncertainty in the parameters and assumptions affects the range of estimates. We conclude that economic costs through labor force participation and productivity along a range of possible economic pathways. The economic damages, however, are driven by estimates of income and GDP growth as well as adaptation measures, specifically the use and effectiveness of air conditioning.

T2-G.2 Goble, R; Clark University; rgoble@clark.edu
Are adaptive strategies feasible and useful in confronting extreme risks?

Adaptive risk management has two key elements: 1) seeking and adjusting to signals of changing conditions and 2) learning from other risk experiences and, when possible, learning as the risk develops over time. Extreme risks are those that exceed societal expectations for the effectiveness of protective measures and in the magnitude of potential consequences. Thus they threaten to overwhelm preventative and response measures whether they are adaptive or not. Furthermore, while, fortunately, their actual occurrences are rare, they therefore provide limited experience for learning. So finding effective adaptive strategies will necessarily be challenging. However, even for catastrophes, there can be a difference between greater and lesser catastrophes, and it is worth seeking opportunities for adaptive approaches that might reduce the likelihood or consequences of extreme threats. There is a further reason for taking a closer look at adaptive strategies. It is quite possible that adaptations designed to mitigate lesser hazards may make extreme events more likely or their consequences greater. A classic story is that of flood plain protection: protective measures against normal floods can increase population density and thus vulnerability to extreme floods. Of course measures to protect against lesser hazards can also be helpful in extreme situations. We can imagine a (shifting) frontier between extreme risks and more manageable risks. It is a fundamental and important challenge for risk analysis to assess how mitigation measures can have an impact, positive or negative, across that frontier. The challenge is directly posed for risks that are extreme versions of a known category of risks; severe earthquakes, hurricanes, and nuclear accidents come to mind. Further challenges are posed by risks that result from unanticipated combinations of severe threats; the Fukushima tsunami-nuclear combined disaster is an example.

T3-A.2 Goble, RL; Clark University; rgoble@clark.edu
Uncertain and changing science, uncertain and changing values: how can assessments be made more useful for adaptive risk governance?

This talk is intended as an introduction to the symposium presentations that follow. It focuses on the context for risk governance and on the tasks needed to create risk assessments that support adaptive risk governance. Expectations for the nature and role of risk assessments have evolved considerably since the founding of the Society for Risk Analysis. The early concept was that assessments were to be decision tools; their task was to show that a risk was lower than some acceptable or tolerable value. This concept came with an ideal urged by Ruckelshaus in the NAS Red Book of 1983: risk assessments should be kept distinct from risk management. The more modern concept is that risk assessments are not in themselves decision tools, but should be used to inform analytic and deliberative processes as described in the NAS Orange Book of 1996. Such a concept enlarges the scope of assessments. To be informative for deliberations, risk assessments must enable comparisons among management alternatives as called for in the NAS Silver Book (2009). Furthermore people can have sharp differences in framing their values and concerns. Assessments must be fair in providing information pertinent to diverse public and stakeholder values and concerns; the distribution of risks, costs, and benefits will matter as well as aggregates; particularly salient for concerns about trust will be the risk management context including the nature of responsibility and recent history. Risk management takes time and deliberation takes time. To maintain relevance and utility over time, “living risk assessments”, assessments that incorporate new knowledge and new understandings, are necessary. But decision and management contexts also change and so will people’s perceptions and values. To be responsive to such changes, living risk assessments require explicit preparations in assessment design and they require mechanisms for ongoing public and stakeholder engagement.

P.9 Coenen, H*; Suchomel, A; Gavrelis, N; Bertelsen, L; Heiger-Bernays, W; Hattis, D; Minnesota Department of Health; Eastern Research Group, Inc.; Boston University School of Public Health; ashley.suchomel@state.mn.us
Alternative approaches for evaluating and providing risk context for water contaminants with minimal toxicity data

The State of Minnesota monitors for contaminants of emerging concern (CECs) such as pharmaceuticals, personal care products, emerging pollutants, and unregulated household products, and unregulated industrial chemicals. The Minnesota Department of Health (MDH) is tasked with determining human health risks from exposure to contaminants in drinking water. Traditional risk assessment methods require chemical-specific toxicity data in order to develop numerical health-based guidance values for drinking water. However, many CECs have little to no available toxicological data, making it difficult to sufficiently evaluate the chemical. In order to develop appropriate public health responses, MDH worked with partners to critically review and test a range of published “generic” screening methods (e.g., threshold of toxicological concern), extrapolation methods, computational tools and the underlying databases (e.g., QSAR tools), and to assess method uncertainties and limitations. The findings were used to develop a systematic decision framework for evaluating contaminants in water. The framework is based on chemical-specific structure/structural alerts and associated toxicological endpoints and also incorporates open-access computational toxicology resources. Through rigorous testing, MDH and partners have developed this framework to address a wide variety of substances and adverse health endpoints. In addition, the overall compatibility of the framework and existing MDH and other state of the science risk assessment principles have been evaluated. MDH has used this decision framework to provide risk context for contaminant occurrence data, develop protective chemical-specific human health guidance, and prioritize contaminants for more indepth analysis.
Standards. systems to other technologies that have been recently
morbidity included life years and a monetary evaluation of the
different metrics: kinetic energy averted, functional lives saved,
morbidity included life years and a monetary evaluation of the
social consequences of the crash. These are estimated using a
wide range of data including actual crash testing of these
systems. We also compare the life saving ability of these
systems to other technologies that have been recently
mandated as part of the Federal Motor Vehicle Safety Standards.

Traffic fatalities have had a steady decline over the last five
decades. However the pedestrian component has recently been
increasing both in absolute terms and as a fraction of total
fatalities. Auto manufacturers have responded by developing
systems to automatically detect situations where pedestrian
crashes are imminent and to intervene by applying the brakes.
These systems can be quite effective for some kinds of crashes
but not others. Our paper develops and implements a detailed
testing protocol that evaluates the performance of these
systems over the range of crashes that are typically
encountered with the major benefit captured with a number of
different metrics: kinetic energy averted, functional lives saved,

Crash-Imminent-Braking Systems
Estimating Benefits and Costs for Pedestrian

Gooptu, A*; Indiana University; agoop1@gmail.com
The Relationship between the Value of Statistical Life and
the Value of Monetary Time
In this paper, I first investigate the value of statistical life (VSL)
measures utilized by federal agencies to assess a policy’s
impact on mortality risk. In addition, I explore the variation in
the estimates of VSL used by federal agencies when conducting a
cost-benefit analysis and hypothesize a few potential reasons
why estimates may vary. Next, I consider if measures such as the
value of monetary time (VMT) can provide an alternative

Analyzing risks of urban roaming dogs
Stray and feral dogs are becoming an increasingly common
sight in many urban areas in the United States. A long
acknowledged problem in cities in less developed countries,
free-roaming dogs pose a serious risk to public health and safety
of humans and other wildlife in distressed cities such as
Detroit. Estimates urban roaming dogs in Detroit range from
8,000 to 50,000 and raise serious risks: 1) Public health threats
including increased exposure to dog bites and transmission of
zoonotic diseases; 2) Criminality related to dog fighting and
animal cruelty; 3) Visible signs of physical disorder; 4) Health
concerns for the dogs themselves. The deindustrialization and
population loss in cities such as Detroit have had significant
effects on urban ecosystems causing “greening” with
abandoned land reverting to urban prairie. There is little
consensus about the scope and severity of the problem. Before
effective risk policy can be developed and implemented to
address emerging concerns about roaming dogs, an analysis
risks associated with the problem is needed. The proposed
paper will provide such a risks assessment with particular
attention to spatial implications answering the following
questions: • What is the population of stray and feral dogs in
Detroit? • What are the spatial patterns in the distribution of
roaming dogs? • How are spatial patterns related to land use, property abandonment, and human population changes? • What
is the extent of human-dog contact? • Are roaming dogs

Gore, MG*; Mauer, B; Pizaro, J; Reese, L; Wilkins, M;
Michigan State University; gorem@msu.edu
Analyzing risks of urban roaming dogs

Risk-of-bias analysis: Case study of pleural plaques and
lung function
A risk-of-bias assessment evaluates study characteristics that
can introduce systematic error and how this error might affect the
bias and/or the observed effect. We conducted a risk-of-bias
assessments as part of a review for the Integrated Risk
Information System (IRIS) process. This review was
published online and discussed in the National Research Council committee report on the IRIS process. A risk-of-bias
assessment is a key element of a systematic review, allowing
study evaluators to determine how confidently conclusions can be
drawn from the evidence. In its draft IRIS assessment for Libby
ampibole asbestos (LAA), US EPA chose pleural plaques as the
most sensitive adverse effect on which to base the reference
concentration (RfC). As evidence for adversity, US EPA cited
several studies that evaluated lung function in subjects with
pleural plaques. We conducted a risk-of-bias assessment as part of
a systematic review evaluating whether the evidence indicates that pleural plaques cause lung function deficits. We
found that studies that used x-ray radiography to identify
pleural plaques were more likely to find associations between
pleural plaques and lung function deficits than studies that
used high resolution computed tomography (HRCT). X-ray
radiography is prone to misdiagnosis of pleural plaques (e.g.
extrapleural fat identified as plaques) and underdiagnosis of
other lung abnormalities (e.g. fibrosis) that affect lung function.
In contrast, HRCT is more reliable because of its superior
contrast sensitivity and cross-sectional imaging format. We
evaluated the literature as a whole, including three studies of
LAA-exposed individuals, and concluded that pleural plaques
alone are not associated with lung function deficits, and that
observed associations in studies using only x-ray radiography are
likely attributable to undiagnosed lung abnormalities. By
evaluating studies using x-ray radiography and HRCT to identify
pleural plaques, we demonstrate how a risk-of-bias analysis can provide valuable insights when conducting a
systematic review.
M3-D.1 Gore, ML*; Ratsimbazafy, JH; Lute, ML; Rajaonson, A; Michigan State University; gorem@msu.edu

Effects of risk perceptions about environmental insecurity on exploitation of natural resources: insight from Madagascar

Environmental insecurity has been linked to increased risk of geopolitical conflict, crime, and over exploitation of natural resources. Insuring environmental security is a goal for risk managers in diverse sectors. Insight about the relationship between risk perceptions about environmental insecurity and natural resource exploitation are nebulus. This gap in understanding is problematic for decision-makers facing dramatic increases in and militarization of natural resource exploitation, particularly when developing countries and endangered species are involved. Such contexts engender severe threats to ecosystem health and human well being. Our objectives were to assess local perceptions of environmental security risks, natural resource exploitation, and acceptability of risk management responses; rank natural resource exploitation relative to other environmental risks; and explore effects of perceptions about environmental insecurity on natural resource degrading behaviors. In June 2014, we conducted 88 semi-structured face-to-face interviews with Malagasy residents in the high priority conservation region of Torotofotsy Madagascar. Madagascar is the world's hottest biodiversity hotspot. Participant perceptions about environmental insecurity were positively related to perceptions of environmental security risks (F = 1.676, p < .05). Wildlife ranked 6th among 8 environmental risks; cyclones and zoonotic disease ranked as the most risky. Wildlife poaching and charcoal activities were not influenced by perceptions about environmental insecurity, yet illegal logging was (F = 2.446, p < .001). The large majority of participants felt security risks should be actively mitigated (79.5%) as opposed to thinking about risks as opportunities for innovation (3.0%). Results can inform the content, design, and implementation of environmental security-based risk communication and help predict local response to risk management strategies designed to improve environmental security.

M4-C.1 Graham, JD*; Liu, CR; Indiana University; grahamjd@indiana.edu

Regulatory and Quasi-Regulatory Activity Without OMB and Cost-Benefit Review

This article examines several types of regulatory and quasi regulatory activity that are occurring outside of OMB oversight and/or without being informed by a cost-benefit analysis. Those types of activities include (1) guidance, (2) state regulatory activity that is explicitly permitted by the federal government, (3) federal hazard determinations related to chemicals and other technologies, and (4) nondiscretionary rulemakings under consent degrees agreed to by federal agencies. Case studies illustrate the important of the rulemakings to the energy, automotive, and housing sectors of the economy. The authors suggest some legislative reforms that can bring such activities within the scope of OMB review and/or cost-benefit analysis.

W4-E.1 Gray, G; GWU Milken Institute School of Public Health; gmgray@gwu.edu

Making Uncertainty Analysis “Fit for Purpose”

Recent advice from the National Research Council has highlighted the need for “decision-focused” and “fit for purpose” chemical risk assessments, and has additionally commented on the need to improve the documentation and analysis of uncertainty. Fitting uncertainty analysis range from screening (i.e., test further or not) to regulatory (i.e., setting limits) to comparative (as in Alternatives Assessment). Tiered assessments have been proposed in some settings to increase efficiency or throughput. Consideration of uncertainty in risk assessments differs across these applications. Some uses of risk assessment focus on “protective” decisions while others require “predictive” risk values to ensure sound decisions. Progress requires more transparency in the consideration of uncertainty in hazard and dose-response analysis to improve communication with users of risk information. Methods of communicating uncertainty range from the qualitative to semi-quantitative to fully quantitative. The characterization of uncertainty may differ by decision context. Another approach is use of margins of exposure (MOE) to force consideration of important sources of uncertainty and variability outside the confines of those considered in “uncertainty factors” commonly adopted in the development of human health risk values (e.g., RfDs). In all cases, it is critical that careful attention is given to factors contributing to the true uncertainty in prediction of human risk (e.g., the relevance of the specific model) versus the commonly considered components of “uncertainty” factors. This work explores the implications of alternative approaches for supporting different types of risk-based decisions.

P.55 Gray, DL*; Vaughan, PH; Stantec Consulting Services, Inc.; deb.gray@stantec.com

Timing is everything. Short-term action levels for TCE in indoor air

A number of EPA Regions and state agencies have established short-term action levels for TCE in indoor air to protect the embryo/fetus of an exposed mother from congenital cardiac defects. EPA Region 10 recommends that average TCE concentrations not exceed 2.0 &#956;/m3 in residences and 8.4 &#956;/m3 in occupational settings over any 21-day period. Detection of TCE concentrations exceeding these short-term action levels may result in removal of building occupants. We examine the practical aspects of implementing acute action levels for a response variable (cardiac development) that has very short and constantly changing windows of susceptibility, and an exposure variable that is subject to substantial temporal and spatial variability. Levels of TCE in indoor air can fluctuate by 1-2 orders of magnitude over short time periods; and can differ markedly between locations within the same building. Gestational weeks 4 through 8 are the periods of highest susceptibility for major malformations of the heart in humans’ with some critical events occurring over hours. We examine 4 hypothetical scenarios illustrating the implications of the developmental stage at which TCE is first detected in the indoor air breathed by the mother at concentrations at or above the acute action level. We conclude that there are significant practical challenges in implementing short-term action levels for TCE. Current sampling and analysis methods may not provide information quickly enough to pre-empt exposures during critical developmental periods. It may only be possible to ‘protect’ against future exposures rather than exposures that are ongoing at the time TCE is discovered in indoor air.
M4-B.4 Greco, SL*; Belova, A; Haskell, JM; Firlie, B; Stedge, G; Hunt, DR; Abt Associates; sue greco@abtassoc.com

Estimating the Disease and Economic Burden of Arsenic in Private Wells in the United States

Approximately 15% of Americans obtain their drinking water from private wells that are not protected by U.S. government regulations for contaminants. Arsenic has been detected in such wells at levels exceeding the U.S. primary drinking water standard. We conducted an analysis to illustrate the magnitude of the disease and economic burden associated with arsenic in unregulated private drinking water wells in the U.S. We assessed arsenic exposure from private wells by estimating separate concentration distributions for each of 13 groundwater regions. To this end, we fit a hierarchical Bayesian model to 1992-2004 United States Geological Survey data. Based on a review and evaluation of the epidemiologic literature, weight of evidence, and potential economic impacts, we examined the following endpoints: cancer incidence and mortality (skin, bladder, and lung) and heart disease mortality. Since the U.S. Environmental Protection Agency (EPA) is currently revising its toxicological assessment for inorganic arsenic, we relied on other available dose-response estimates (e.g., cancer slope factors from previous EPA estimates, hazard ratio relating arsenic in drinking water and heart disease mortality from a recent prospective cohort study in Bangladesh). We developed cost-of-illness estimates for non-fatal cases of (1) non-invasive and invasive bladder cancer, (2) Stage I and Stage II lung cancer, and (3) basal cell, squamous cell non-invasive and invasive skin cancer. For each endpoint, we developed typical treatment profiles then calculated cost estimates comprised of direct medical costs and indirect opportunity costs. EPA’s Value per Statistical Life was used to estimate the economic burden of fatal cancer cases and excess heart disease mortality risk. We used the SafeWater CXB model to perform a two-dimensional Monte Carlo analysis of variability and uncertainty in generating estimates of the burden of arsenic in private water wells.

P.56 Greene, CW*; Shubat, PJ; Minnesota Department of Health; christopher.greene@state.mn.us

Exposure Assessments for Contaminants of Emerging Concern

Development of drinking water guidance for chemicals of emerging concern (CECs) requires a change in perspective from the methods used for other water contaminants. For many CECs, even those which may be present in drinking water sources, drinking water is not the primary source of exposure. Some CECs (phthalates, BPA, flame retardants) exhibit near ubiquitous exposure in the U.S. population from the use of consumer products; others (fragrances, pharmaceuticals, DEET) are deliberately placed on or in the body. A few CECs (triclosan, microcystin, acrylamide) may approach or exceed toxic thresholds from consumer product or dietary exposures. The Minnesota Department of Health (MDH) addresses these exposure assessment issues in a rigorous review process when it develops health-based guidance values for CECs in drinking water. The review process includes an exposure assessment involving multiple exposure routes and the development of chemical-specific Relative Source Contribution (RSC) factors to account for potential non-drinking water exposures. RSCs and guidance values are developed for multiple exposure durations. Exposure and RSC assessments for CECs include analysis of published data on occurrence, exposure estimation, and biomonitoring, as well as the use of appropriate computer models to estimate exposures from multiple media and routes. MDH’s practical application of the RSC involves the consideration of measured and modeled data and the judicious apportionment of exposure and risk across both water and non-water routes. Results, discussion, and policy implications of exposure and RSC assessments for chlorpyrifos, isobutanol, acrylamide, nonylphenol, and other chemicals will be presented.

W2-J.1 Greenberg, MR; Rutgers University; mrg@rci.rutgers.edu

Health Impacts of Long-Term Displacement Following Hurricane Sandy

In order to ascertain the general and mental health impacts associated with Hurricane Sandy, survey data were collected from almost 800 residents who had been displaced for at least a month in 2012. Striking differences were found in self-reported mental health and general health symptoms. These were associated with lengthy displacement, loss of contact with neighbors and friends, anger with their insurance handler, and older age. Suggestions are offered to address these symptoms.

W3-E.2 Greidinger, SJ; Greidinger, Steven; Predictive Health Solutions; sjgreidinger@gmail.com

Toward a Risk Analysis Framework for Synthetic Biology

Synthetic biology techniques offer possibilities for increasing the food supply, increasing the energy supply, decreasing risks from climate change and advancing medical science. At the same time, however, these techniques have been identified as a potential source of harm from unintentional microbial release, biological weapons deployment and human germline genetic alteration. This talk will present work toward the development of a risk analysis framework which could allow for quantitative understanding of whether and how to restrict the development of synthetic biology technology. Methods will also be discussed which can assist in determining the level of investment which is appropriate for developing robust biodefense countermeasures.
Incorporating Tox21/ToxCast Endocrine-Related Data into GreenScreen Chemical Hazard Assessment

Endocrine active chemicals have an inherent ability to interact with the endocrine system resulting in biological, but not necessarily adverse, effects. GreenScreen®#61650; for Safer Chemicals hazard assessments include evaluation of endocrine-related activities as part of the Tox21 HTS initiative. HTS data from Tox21 and ToxCast were incorporated in GreenScreens on over 50 chemicals performed as part of a chemicals alternatives assessment. Of these, 16 chemicals have been assessed for endocrine related activities as part of the Tox21 HTS initiative. HTS assays performed to date included estrogen, androgen, thyroid hormone, and thyroid stimulating hormone receptor binding (both agonism and antagonism). For the 16 chemicals, 15 did not interact with endocrine receptors. One chemical, 1,3,5-trimethylbenzene, was active in 1 of 6 androgen receptor agonist assays; however, whole animal studies indicate it is not likely endocrine active. For 3 of the 16 chemicals, IgF1, tramethoxy(methyl)silane, and xylene, the lack of interaction with endocrine receptors conflicted with moderate endocrine activity scores based on animal data in the GreenScreens. Additional testing is necessary to elucidate mechanisms of the effects observed in the animal studies. This exercise demonstrates the challenges associated with using Tox21/ToxCast HTS data in GreenScreen chemical hazard assessments.

Quantitative risk assessment for human toxoplasmosis through consumption of pork products in the U.S.

Toxoplasma gondii is one of the leading foodborne pathogens in the U.S. The Centers for Disease Control and Prevention (CDC) reported that T. gondii is one of three pathogens (Salmonella and Listeria), which together account for >70% of all deaths due to foodborne illness in the U.S. Consumption of raw or undercooked pork products in which T. gondii has encysted (or an important transmission route for human infection. The goal of this study was to develop an abattoir-to-table quantitative microbial risk assessment (QMRA) model to analyze the risk of illnesses through consumption of different pork products in the U.S. Cysts numbers were calculated in each major pork cut (picnic, Boston butt, ham, loin and belly) of an infected pig because tissue cyst is unevenly distributed in each commercial cut. Based on experimental studies in mice, two logistic regression equations were used to model the reduction of T. gondii during meat processing and home cooking. The distribution of the exponential dose-response relationship parameter was estimated by derived distribution through bootstrap approach. T. gondii prevalence in pig was described by a weighted prevalence obtained through a meta-analysis of 16 and 9 peer-review studies on conventional-raised and organic-raised pigs, respectively. The QMRA model was developed in a Monte Carlo probabilistic framework to account for uncertainty and variability in model parameters and input variables. The mean probability of infection for servings of fresh pork products ranges from 2.3E-6 to 6.48E-10, corresponding to 34 to 21,734 infections annually in the U.S. The five most consumed pork products (fresh ham, pork chop, rib, picnic roast and tenderloin) associates with 35,334 infections per year. Sensitivity analysis suggests that T. gondii reduction during meat cooking is the most important parameter for human health risk. T. gondii infection rate is meat- and product-specific and may cause severe health outcomes in high-risk populations.

Demanded compensation for environmental risks: it all depends on the economic sector

The present work contributes to understand how does the public opinion feel about environmental effects caused by the main economic activities in Chile. In this way, this paper tackles the issue of how acceptable are these hazards, how much does the population demand in order to be compensated for these impacts; how big is the risk perceived by citizens, and finally how much do they trust governmental agencies that are responsible for regulating these impacts. Furthermore, we also study whether the relation between the relevant variables (social acceptability, perceived risk, trust in regulatory institutions and demanded compensation) depend on the type of economic activity or the environment affected. Our data consists on a novel survey carried out to 421 participants that asses 16 environmental hazards generated by the four most influential economic sectors in the country: Mining, Agriculture and livestock, Fisheries and Urbanization. We find that both social acceptability and demanded compensation depend on the type of economic activity that generates the hazards and not on the particular environment affected. On the other hand, perceived risk depends on both factors. Trust in regulatory institutions, on the contrary, is independent of the type of economic activity or the environment impacted. These results are not only a theoretical contribution, but also in line with previous findings that claim that, social acceptability should also decrease when increasing confidence in regulatory institutions. Moreover, demanded compensation should significantly decrease due to a lower perceived risk.
T3-D.1 Guzman, K*; Wyss, G; Sandia National Laboratories; kkguzman@sandia.gov
Challenges of Risk Management in National Security
National security risk management poses challenges to the traditional quantitative risk management toolkit in four significant areas. The first challenge is data uncertainty. The national security landscape is marked by lack of historical data for malicious events. When data exist, they can be characterized by high uncertainty or inconsistency in availability. The lack of historical data coupled with uncertainty in adversary information together pose a significant challenge to quantification of likelihoods or probabilities. Decision lifetimes are a second challenge, particularly for national security investment decisions, where the impact of a decision could outlive current information by many years. Use of threat information is particularly challenging when the threat can change on a much shorter time scale than the lifetime of a risk mitigation investment, which may require years of research and development, or may live in the field for a decade or more. Transparency of risk message is a third challenge, as national security decisions warrant a level of transparency to all stakeholders, from interagency representatives to Congress and industry partners. This breadth in stakeholders necessitates not only transparency in risk methodology and in data provenance but also necessitates a clear, concise risk message that can be consistently communicated across stakeholder groups. Stakeholders often value simplicity in risk message and risk methodology. The fourth challenge is decision timelines. National security decisions can be time-sensitive, not affording the analyst the luxury of lengthy or iterative risk analyses. Long duration risk analyses may not be available in time to be considered by decision makers. This talk will discuss these challenges of risk management in national security, provide examples of alternative approaches to managing risk in the national security setting, and pose areas of future research for the risk community.

T3-I.4 Haavik, TK; NTNU Social Research; torgeir.haavik@samfunn.ntnu.no
Risky accounts: Uncertainty as a resource for safety
In this article we address the phenomenon of uncertainty. We review briefly the different meanings of uncertainty in different domains such as the risk analysis field, decision-making theory, organisational safety literature, the sociology of modernity and risk, and actor-network theory. We then – inspired by the Safety-II discourse – investigate the appearance and role of uncertainty in a concrete setting of normal offshore drilling operations; a complicated domain both in technological and organisational terms, and with a considerable accident potential. The article introduces actor-network theory and the way uncertainty has been treated in the field of science and technology studies. We show the value of bringing together the two fields of science and technology studies and safety science, and invite to further exploration of this unusual, but highly fruitful, blend of perspectives and approaches. Through the elaboration of “risky accounts” – a way of accounting for a system’s heterogeneous actors, interactions, borders, and knowledge building and structures – we demonstrate a promising potential of approaching studies of normal operations and safety by addressing uncertainty. We demonstrate theoretically and empirically that uncertainty may be a resource for safety, and – acknowledging that the relationship between uncertainty and safety is indeed not unambiguous – we reflect upon the preconditions for turning uncertainty into an asset for safety rather than a driver for accidents.

WI-I.4 Haas, CN*; Hoque, S; Farouk, B; Drexel University; haas@drexel.edu
Development of Metamodels for Predicting Aerosol Dispersion in Ventilated Spaces
Modeling of exposure in the indoor environment has been conducted primarily using zonal/box models (e.g., CONTAM) and computational fluid dynamics (CFD). Zonal models, while relatively rapid computationally, have low spatial resolution. CFD models can have very high spatial and temporal resolution, and with the inclusion of the required physics increasing computation time is added to a model that is already computationally intensive and requires extensive time to set up. Here we introduce the concept of metamodeling of exposure in the indoor environment. Metamodels are computationally simpler approximations of complex physics-based simulations. We consider the problem of dispersal of aerosols (e.g., bioaerosols) in a room. Using CFD, we are able to model dispersal of aerosols in rooms with different design aspects (air change rate, geometry, location of inlet and exhaust, etc.) for aerosol release simulating the opening of an envelope. The CFD runs were conducted using a design of experiments approach over the design space as parameterized by dimensionless groups. The transient output from CFD simulations of dispersal from an instantaneous source of aerosols was well approximated by a neural network. The strategy for conducting the CFD in silico experiments, and the training and validation of the neural network will be discussed. It is anticipated that such neural networks, after further verification using field sampling, could be used for rapid response to an adverse incident, implement design interventions if required as well as in the a priori design of more resilient spaces for the protection of occupants from risks associated with release of bioaerosols or toxins.

P.181 Haidari, I; Afghan Intermediate Medical Institute; Inayat.Haidari@hotmail.com
Overcoming the population crisis in Afghanistan: Implementing effective and safe birth control methods in rural areas
Rapid population growth is the main culprit as to why many countries suffer from poverty, one being Afghanistan. Family planning remains to be a struggle in Afghanistan – mainly in rural areas – due to lack of contraception and birth control education. Although improvements have been seen in the past decade due to a large amount of international involvement aimed to counter these trends, Afghanistan remains to maintain a very high birth rate of 38.84 births for every 1000 persons – ranking it the tenth highest in the world (Central Intelligence Agency, 2014). Higher birth rates pose a threat to the nation’s economy, preventing it from achieving financial stability. The main challenge that interferes with achieving success in regards to lowering birth rate in Afghanistan is its conservative, male-dominated Muslim society. In rural areas under the Taliban control, majority of the women require permission from a male relative for most decisions. We argue that a successful method to implement family planning in Afghanistan would be to adopt the BKKBN system that was used in Indonesia to control their birth rates. This population control program was the most successful in history, bringing Indonesia’s total fertility rate from nearly 6 when the program began in 1970 to 2.59 in the 1999 (Barnwal, 2004). Similar results are attainable in Afghanistan considering that Indonesia too consists of a majority Muslim population.
The (U.S.) National Library of Medicine’s information resources for toxicology, exposure science, and risk assessment: Recent enhancements and future plans

The (U.S.) National Library of Medicine (NLM) provides online resources for toxicology, exposure science, and risk assessment. The National Library of Medicine Services Division (SIS) is responsible for information resources and services in toxicology, environmental health, chemistry, and other topics. This includes databases and special topics Web pages, with special emphasis on Web pages optimized for mobile devices. One resource is the TOXNET (TOXicology data NETwork, toxnet.nlm.nih.gov), with a recent new interface providing improved “one stop access” to TOXNET’s suite of databases. TOXNET’s Household Products Database recently added “Commercial/Institutional” as a new product category, and TOXNET’s Hazardous Substances Data Bank (HSDB) continues to be enhanced to include materials of emerging interest. HSDB is also adding state-of-the-science toxicology, exposure, and risk assessment information, and images (e.g., metabolic pathways). Further, NLM SIS recently developed an enhanced version of its ALTBIB Web portal to provide better access to information on in silico, in vitro, and improved (refined) animal testing methods, along with information on economic costs. Additionally, NLM SIS also developed a database linking jobs, hazardous tasks, and occupational diseases and their symptoms. A further development of NLM SIS–developed resources is the Enviro-Health Links (EHLs). The EHLs are Web bibliographies of links to authoritative and trustworthy online resources in toxicology and other topics. Two recent additions to the collection of EHLs are: 1) Nanotechnology and Human Health, and 2) Tobacco, Smoking, and Health.
**Development of a Benefit Transfer Function to Value Reductions in Morbidity Risk for Health and Safety Regulations**

Although the value of reducing mortality risk is well studied, benefit-cost analysis of health and safety regulations must often resort to indirect and incomplete methods to quantify the value of reducing morbidity risk. Until recently, however, there has been little research on the empirical relationship between willingness to pay and the duration and severity of illness. This project builds upon this research to provide analysts with better tools for benefit-cost analysis. In particular, we develop a database of studies that provides estimates of willingness to pay, based on primary research, for a defined severity of illness. We then develop a benefit transfer function that can be used to estimate the value of reductions in morbidity risk for health and safety regulations.

**Preferences for Life-Expectancy Gains: Sooner or Later?**

Increases in life expectancy can be produced by transient or chronic reductions in mortality risk at different ages. Using surveys of the general French population between ages 20-70, we are investigating individuals' preferences for alternative perturbations to their survival function that yield the same increase in life expectancy, e.g., a transient reduction in annual mortality risk for the next 10 years and a reduction that begins small but increases with baseline annual risk and persists until death. 23 percent of the respondents reported strict indifference and 15 percent made intransitive choices over the different perturbations. The rest of the respondents have clear preferences over the three ways of generating a given gain in life expectancy. Older individuals and those with higher income tend to be more risk-seeking with respect to longevity. Financial risk aversion does not seem to play a role on the preferences over the scenarios. Respondents with higher consumption discount rate prefer to get the reductions in mortality risk early in their future life. Those that expect to have high levels of life satisfaction in the future prefer to get risk reductions later in their life.

**Platforms to Inform Nanotechnology Risk Decisions**

Computational approaches using experimental data are critical to gain knowledge and understanding of the fundamental principles that govern nanomaterial fate and effects in the environment, as well as their biological interactions and impacts. Currently, data that is generated in the rapidly emerging field of nanotechnology is extremely diverse and generated by disparate sources. In addition, there are a variety of nanomaterials for which the characteristics that are important for determining their environmental fate and interactions with living systems are completely unknown to date. Hence the pressing need for a concerted effort to organize and mine disparate information coming out of current research efforts. Much progress has already been made through grassroots efforts in nanoinformatics with a multitude of resources and tools for nanoscience researchers being established for application in nanotechnology environmental health and safety. While these tools and data resources are beginning to emerge, it is imperative to think forward as a community and establish a common conceptual framework for data integration that includes leveraging existing resources, islands of data, and predictive models. Specific examples around nanotechnology environmental health and safety will be used to illustrate the value added for different sectors once data integration and data reuse are commonplace. A comparative approach taken to compare the results of several different models built to predict toxicity from the open-source data on nanomaterial toxicity to embryonic zebrafish (Danio rerio) found in the Nanomaterial-Biological Interactions (NBI) knowledgebase at Oregon State University will be presented. A standardized data sharing format will also be presented.

**Assessing and Managing Risks to the Social and Cultural Integrity of Climate-Displaced Indigenous Communities**

Indigenous communities are at disproportionate risk from climate change since they are more embedded in the environment, but adaptation tends to be an individual community response rather than a broad systematic response by the federal government. Ultimately the evaluation of risks and impacts has to fit unique community conditions. However, recognition and response from the federal system would benefit from a more systematic methodology for evaluating risks and impacts to the cultural and social aspects of community well-being and quality of life. Components of a cultural risk framework will be discussed, and examples of several frameworks that have been developed. These frameworks include the Millenium Ecosystem Assessment, various quality of life indicator sets, an Indigenous Health Indicators model, and a Natural Law (Tamanwit) model, and an EPA Human Well-Being Index. These frameworks can provide information to identify, assess, and manage climate impacts, as well as define the scope of impact endpoints to federal and state partners and responders.
Development of a Quantitative Food Supply Vulnerability Tool Exploring Public Health Risks

The Food Safety Modernization Act (FSMA) Section 106 requires that a vulnerability assessment of the food system be conducted, including biological, chemical, radiological or other risk assessments. While defining vulnerability the Department of Homeland Security (DHS) noted that a practical measure is the "likelihood that an attack is successful, if it is attempted". The success of an attack on the food system depends both on the malicious actor gaining access to the product to contaminate it, and the ability of the hazard to persist in the product at high enough concentrations to cause health or economic impacts after distribution. This characteristic has traditionally been the domain of food safety, but is equally relevant to food defense. We are developing a web-based food supply chain vulnerability assessment tool for agents of concern, which provides quantitative estimates that directly measure risk and vulnerability using public-health based metrics. Several tools are available that explore aspects of vulnerability of the food supply. However, these tools cannot be readily applied to quantitatively explore vulnerability in terms of public health. Our tool is generic in nature, enabling application to multiple food-hazard combinations (applicable to both microbial and chemical/toxicological hazards) and enabling exploration of the impact of risk mitigation measures upon the vulnerability of a food production/processing system. Use of the tool will provide stakeholders with science-based quantitative information that can be directly used to inform decisions improving the resilience of the supply chain and minimizing the risks to the consumer.

The Henkel Sustainability Master® combines various instruments for measuring sustainability. This evaluation system centers around a matrix based on the individual steps of our value chains and on our six focal areas. The goal is to increase the value (performance, health and safety, and social progress) of a product and simultaneously reduce its environmental footprint. Hot spots can be identified for every product category on the basis of scientific measurement methods, e.g. life cycle analyses and empirical data. A specified hot spots, e.g. product safety can also be investigated by using this tool to compare the sustainability profile of two products or processes, thus allowing changes to be quantified; developers can use these findings for innovation and continuous product improvements. Under this framework, Henkel applies comprehensive risk-assessment procedures to ensure that all our products and their ingredients are thoroughly evaluated before they go to market. In addition to relevant product life cycle factors, our overall product safety evaluation also includes the assessments on the risk/benefit ratio, economic impact and feasibility of substitution. Collaboration among the business partners in the value chain, and consumer education based on a science-based, holistic approach toward product safety are critically important for the public interest and industry's future business success.
DRAGON is an online database and software tool developed by ICF International to help an assessor conduct a systematic literature review for a science question. To carry out a systematic literature review, a scientist formulates a question (e.g., Does chemical X cause cancer in humans?), conducts a search of published literature related to that question (looking in, for example, PubMed, and other similar literature databases), and evaluates the literature to develop a conclusion. Preferably, the literature review will comprehensively evaluate all available evidence relevant to the question at hand; however, the amount of data to be reviewed can be large to the point of overwhelming. ICF created DRAGON to manage the systematic review process in an efficient, transparent, and methodical manner, which is consistent with NRC’s recent recommendations to EPA with respect to systematic review for chemical risk assessment. The tool includes data entry modules to input and store quantitative and qualitative data presented in the references, facilitates independent evaluation of the relevance and quality of references by two or more scientists, and assists in managing the overall workflow for a team of scientists contributing to different activities for a chemical. The modular construction of DRAGON allows for flexibility in conducting assessments at a range of sizes and stages and facilitates further expansion and development of tool capabilities, and the construction of DRAGON as an online tool enables an assessor to deploy a multi-user team.

The Framework for Human Health Risk Assessment to Inform Decision Making in Conducting Chemical Risk Assessments under the Toxic Substances Control Act

T. Henry, K. Anitole, K. Austin, C. Baier-Anderson, A. Benson, I. Camacho, K. Eisenreich, S. Laessig, J. Seed, Y. Selby-Mohamadu, T. Stedeford, M. Szilagyi, M. Townsend, E. Wong The Framework for Human Health Risk Assessment to Inform Decision Making (“HHRA Framework”) was developed by EPA’s Risk Assessment Forum to enhance transparency and consistency in developing and describing Agency assessments of risk. During the development of the HHRA Framework, it became clear that problem formulation and utility are concepts that are being embraced by the risk assessment community. A notable example of the application of the Framework is assessments conducted by EPA’s Office of Pollution Prevention and Toxics (OPPT). In March 2012, OPPT identified a work plan of 83 chemicals for further assessment under the Toxic Substances Control Act (TSCA) as part of EPA’s comprehensive approach to enhance the Agency’s existing chemicals management program. OPPT intends to use the TSCA Work Plan Chemicals to help focus and direct the activities of the Existing Chemicals Program (http://www.epa.gov/oppt/existingchemicals/pubs/workplans.html) over the next several years and is applying the concepts and guidance provided in the HHRA Framework to develop its risk assessments. In particular, OPPT conducts a robust Problem Formulation as the first step in each assessment, to ensure the resulting assessment is “fit for purpose” within the TSCA context. OPPT risk assessors engage in a dialogue with our risk managers early in the process to ensure the assessment will inform potential risk management options. OPPT also develops a chemical-specific conceptual model for each assessment that follows the source to outcome continuum within the TSCA context and lays the foundation for development of the analysis plan for each assessment. Applying the principles and practices outlined in the HHRA Framework facilitates the process for conducting TSCA human health risk assessments and improves the utility of risk assessments to inform decisions for risk management.
Application of the Framework for Human Health Risk Assessment to Inform Decision Making in Conducting Chemical Risk Assessments under the Toxic Substance Control Act


The Framework for Human Health Risk Assessment to Inform Decision Making (“Framework”) was developed by EPA’s Risk Assessment Forum to enhance transparency and consistency in developing and describing Agency assessments of risk. During the development of the Framework, it became clear that problem formulation and utility are concepts that are being embraced by the risk assessment community. A notable example of the application of the Framework is assessments conducted by EPA’s Office of Pollution Prevention and Toxics (OPPT). In March 2012, OPPT identified 83 chemicals for further assessment under the Toxic Substances Control Act (TSCA) as part of EPA’s comprehensive approach to enhance the Agency’s existing chemicals management program. OPPT intends to use the TSCA Work Plan Chemicals to help focus and direct the activities of the Existing Chemicals Program over the next several years and is applying the concepts and guidance provided in the HHRA Framework to develop its risk assessments. OPPT conducts a robust Problem Formulation as the first step in each assessment, to ensure the resulting assessment is “fit for purpose” within the TSCA context and lays the foundation for development of the analysis plan for each assessment. Applying the principles and practices outlined in the HHRA Framework facilitates the process for conducting TSCA human health risk assessments and improves the utility of risk assessments to inform decisions for risk management.

Evolution of Collaborative Networks for Adaptive Risk Management

Adaptive risk management is needed to effectively deal with emerging, complex, and conflictual problems of environmental risk. It is widely recognized that successful risk management requires collaboration among scientists, decision makers, and other policy stakeholders representing a wide variety of organizations and substantive issues. But while these patterns of collaboration, or “networks,” are commonly viewed as important, we know relatively little about the conditions under which collaborative networks are more (or less) likely to be effective. This makes it difficult to recommend clear strategies for how organizations should use their resources to seek out and maintain working relationships such as information exchange, resource sharing, or joint implementation of programs. Drawing from a unique survey of U.S. environmental risk policy professionals conducted over three decades, this paper examines how networks for adaptive risk management have evolved over time, and how these networks have influenced the ability of particular risk organizations (including federal, private, and nonprofit actors) to achieve their missions and effectively manage environmental problems. Results indicate that organizational networks increasingly cut across multiple issues, sectors, and levels of government, although ideological polarization in networks may inhibit effective risk management. We review the practical implications of these results for the design of institutions to promote learning for sustainability.
**T2-B.2** Heo, J*; Adams, PJ; Carnegie Mellon University; heo@cmu.edu

**Air Quality Social Costs: Developing a Better Model**

Precise evaluation of the impact of air quality on public health is valuable to societal decision-making. However, the evaluation of air quality is not simple because it requires account for complex atmospheric physical and chemical processes of pollutants, associated human exposure, dose-response relation, and economic valuation. Employing a state-of-the-science chemical transport model (CTM) provides the best estimates of air quality science at detailed spatial and temporal resolution. However, because CTMs are computationally too expensive to run, policy research often relies on tools based on simplified approaches, such as remarkable change understanding of organic processes and tropical forest regions. We developed a method to build an air quality social cost model that overcomes these limits: high computational requirement of CTMs and overly simplistic atmospheric algorithms of reduced-form models. We aim to parameterize social cost in terms of dollar per tonne of air pollutant emitted based on nearby population density and key atmospheric variables. Our approach is to create a dataset for a set of sample locations by running a CTM called PMCAMx and then to derive a social cost model by regression. We have built a dataset based on PMCAMx and sulfur dioxide in an intuitive functional form. They predict the PMCAMx-based estimates within a factor of two while requiring negligible computational requirements. Our method provides air quality social cost tools that perform like a CTM but without computation costs. We are currently working on other species: nitrogen oxides, ammonia, and organic aerosols.

**T3-J.2** Herovic, E; Sellnow, TL*; University of Kentucky; emina.herovic@uky.edu

**The Unification and Identification of Bosnian Expatriates During the Flood Disaster in the Balkans**

On May 13th Bosnia-Herzegovina, Croatia, and Serbia were hit with heavy and continuous rainfall causing some of the worst flooding the region has seen in over 120 years. An estimated 40 people died and millions of people have been displaced. Many villages and town have been destroyed and many more are still at risk. Formal organizations, such as the UN and the respective governments are responding to the crisis. More surprisingly, however, are the ephemeral organizations that are arising in response to the crisis. Tens of thousands of citizens are volunteering to help, and an abundant amount of expatriates are responding in their host countries, sending supplies and money, and raising awareness of this event on social media and asking others to donate. As the world becomes increasingly more global and we become international citizens, individuals have a stake in the outcomes of not just one country, but multiple countries. In this case, expatriates identify strongly with their native country and felt obligated to contribute to the response efforts. Historically, the Balkans is plagued by ethnic divisions that linger to this day. These divisions have, in the past, inspired violence in crisis proportions. However, this crisis has been reconciling in some sense, as the three ethnically divided regions work together to improve relations and conditions. Through interviews with Balkan expatriates and a social media analysis, this study examines the role of expatriating in risk and crisis events. The objectives of this project is to explore the potential for expatriates to contribute to a nation’s response to a national disaster (Driskell & Camp, 2006). This form of identification through disaster has been explored in previous research. No past research, however, has focused on unification or identification of actions that have previously had such a contentious history.

**WI-A.2** Herraig, E; Elvira, V; Hernández-Coronado, P; Ríos Insua, D*; Alfaro, G; Gomez, J; Spanish National Aviation Authority (AESA), Royal Academy of Sciences and SKITES; javier.gomezmi@gmail.com

**RIMAS: A risk analysis methodology for aviation safety**

To implement a preventive approach for safety oversight and management at a country level, nations must develop a so-called State Safety Program (SSP), as required by ICAO, the International Civil Aviation Authority. Safety management systems support strategic decision-making problems to adopt better decisions when allocating limited resources to areas with higher safety risks. These systems’ main processes consist of hazard identification, risk evaluation, safety assurance and safety promotion. Based on these four processes, States may make better decisions in an uncertain environment in relation with safety risks. However ICAO promotes the use of risk matrix based methods, with well-known criticisms, see eg.. Cox (2009). As an alternative, within AESA (the Spanish National Aviation Authority), we are developing a more rigorous methodology to our safety management decision processes, which we call RIMAS (Risk Management in Aviation Safety). To our knowledge, this is the first time that advanced OR/RA techniques are introduced in processes related with the preventive approach to safety oversight in civil aviation. Key issues include Bayesian forecasting of aviation accidents and incidents (based on Poisson processes), their typology (based on multinomial Dirichlet models) and consequences, with careful expert judgment elicitation, and the use of decision analysis methods for security resource allocation towards risk management. We shall describe the main ideas about RIMAS, as well as its software implementation.

**T4-E.3** Herring, CE*; Stinson, J; Landis, WG; Western Washington University; carlie.herring@gmail.com

**Evaluating non-indigenous species eradication options in a Bayesian network derived adaptive management framework**

Many coastal regions are facing problems with the introduction and spread of non-indigenous species (NIS). Common efforts addressed by these introductions are eradication (e.g., chemical and/or mechanical treatment options), or single species eradications, with chemical eradication (e.g., ballast water treatments) or single species eradications, with chemical and/or mechanical treatment options. Little information is available as to the outcomes of some of these eradication practices in terms of ecological and toxicological impacts to the surrounding habitat. A regional risk assessment using a Bayesian network model was conducted in Padilla Bay, Washington, a National Estuarine Research Reserve. The objectives of this study were to 1) determine the region and endpoint that are at higher risk from impacts of NIS invasions and 2) calculate and compare risk reduction when implementing a ballast water adaptive management treatment, while being least disruptive to the estuarine community. Bayesian network models are advantageous because they are parameterized with quantitative data and knowledge, providing risk calculations for the current risk to the various regions and endpoints. Further, adaptive management options are easily incorporated into the model for controlling NIS. The southern portion of Padilla Bay, Regions 3 and 4 had the greatest risk associated with them, and the Changes in Community Composition, Dungeness Crab, and Eelgrass were the endpoints with the most risk due to NIS introductions. The ballast water adaptive management treatment displayed little reduction in risk (~1%). These models provide an adaptable template for other coastal regions interested in the eradication of NIS.
Potential health risks of engineered nanoparticles (ENP) are increasingly studied in cellular and laboratory-animal experiments, but there is a lack of health effects data for humans exposed to ENP. However, there is an abundance of human data for another source of nanoparticle (NP) exposure, notably for NPs found as part of diesel exhaust particulate (DEP). Studies of human volunteers exposed to diesel exhaust (DE) in research settings report DEP number concentrations (i.e., >106 particles/cm³) that exceed number concentrations reported for worst-case exposure conditions during ENP manufacturing and handling. Recent human DE exposure studies, using sensitive physiological instrumentation and well-characterized exposure concentrations and durations, suggest that elevated exposures to pre-2007 DE may trigger short-term changes in, for example, lung and systemic inflammation, thrombogenesis, vascular function, and brain activity. In these reports, considerable uncertainty remains as to (1) which DE constituents underlie the observed responses (i.e., NPs, DEP mass, DE gases), (2) the relevance of these findings to New Technology Diesel Exhaust (NTDE), and (3) the implications of the observed short-term changes for the development of disease. Recognizing that physicochemical properties that may be of toxicological relevance can differ between DE NPs and engineered NPs, DE human clinical data do not provide evidence for the unique toxicity of NPs compared to other small particles. Overall, the DE human clinical data do not support the idea that elevated levels of NP exposure per se must be toxic by virtue of the NP content alone.
Veterinary response during disasters involving chemicals: Applicability of lessons learned from recent disasters to chemical mass casualty events

In the United States and elsewhere, pets are considered an integral part of a household and even members of the extended family. Case studies and disaster response lessons learned have shown that many individuals will not evacuate or take action if there is inadequate care available for their animal family members. This poses an increased health risk for response personnel and individuals unwilling to comply with recommendations. Planning and response for pets during a chemical disaster is generally limited to local animal shelters and government entities. Decontamination procedures, response treatment protocols, and post-exposure care for pets are rarely addressed or understood. Chemical and radiological events of a magnitude to be considered a disaster happen infrequently, limiting the capacity to develop response expertise. A great deal of effort has been directed at preparing for response to affected people. An emerging area of emphasis is veterinary response during disaster response and recovery.

This poster presentation summarizes: •The concerns and logistical considerations for veterinary response during disasters involving chemicals •Lessons learned from previous disaster response activities •An applied research plan for identifying improved response resources Lessons learned will target major disasters with documented impacts on pets and veterinary response including: •2013 Colorado floods •Fukushima Daiichi nuclear disaster •Hurricane Katrina This poster topic represents a future feature of the National Institutes of Health (NIH) / National Library of Medicine (NLM) Chemical Hazards Emergency Medical Management (CHEMM) resource which would enhance the content related to veterinary response resources related to chemical disasters. (http://chemm.nlm.nih.gov/sourcesofcheminfo.htm#vet)

Recent advances in chemical toxidromes: Consistent lexicon and emergency response tools

A common language to categorize clinical manifestations of toxic chemical exposures is essential for preparing emergency responders and first receivers to provide medical care to victims of mass casualty events. Military and civilian responders use a “toxic syndrome” (toxidrome) approach when information on chemical exposures is limited. This poster describes the toxidromes used in the National Institutes of Health (NIH) / National Library of Medicine (NLM) Chemical Hazards Emergency Medical Management (CHEMM) system resources (http://chemm.nlm.nih.gov/) and summarizes three related projects. Consistent Lexicon and Outreach Plan - NLM is working with other agencies to develop a consistent lexicon to describe toxidromes. This poster summarizes the approach used to define and present the toxidromes developed. It also summarizes a recently developed outreach plan (http://chemm.nlm.nih.gov/whatsnew.htm#sect3) intended to produce engagement, awareness, acceptance, and use by the stakeholder community. The CHEMM-IST Tool - The CHEMM Intelligent Syndromes Tool (CHEMM-IST, http://chemm.nlm.nih.gov/chemmist.htm) is a prototype decision support software tool for first responders trying to identify the chemical causing a mass casualty incident by relating victim symptoms to toxidromes. This poster describes CHEMM-IST, the technical approach, and an evaluation and validation plan intended to move CHEMM-IST from its current state to a product ready for use in operational response environments. CHEMM Cards - The CHEMM Toxidrome Cards are quick reference cards that help responders identify and respond to chemical exposures. Each card summarizes information about a toxidrome. This poster describes the Cards and how they are intended to meet the needs of first responders in the field.
Cracking the nut: Salmonella tree nut risk assessment. The consumption of tree nuts such as almonds has been linked to several outbreaks of salmonellosis, and Salmonella spp. contamination has been detected in a variety of tree nuts destined for human consumption including for instance Brazil nuts, macadamia nuts, walnuts and pistachios. Product recalls and outbreaks emphasize the need to assess food safety risks associated with raw or ready-to-eat (RTE) tree nuts and to evaluate the appropriate risk-based preventive controls needed to reduce the risk of salmonellosis to an acceptable level. The exact sequence of events leading to salmonellosis from consumption of tree nuts is not fully understood, but potential contamination and cross-contamination opportunities exist within tree nut facilities and at preceding points of the supply chain. For instance, after one outbreak associated with almonds, the Salmonella outbreak strain was found to persist in affected orchards for at least five years, emphasizing the potential for long-term environmental persistence. To quantify the public health risk associated with the consumption of tree nuts potentially contaminated with Salmonella spp., and to evaluate the impact of preventive controls on the risk of human salmonellosis arising from consumption of such tree nuts, the U.S. Food and Drug Administration has commissioned a quantitative microbial risk assessment. The risk assessment model will be used to evaluate current practices used in the United States and to quantify potential cost of risk mitigation options. This presentation will provide an overview of the risk assessment approach and present key findings.
Bayesian Network Analysis Comparing Human Health Risk Values Across Organizations

Environmental and public health organizations including the World Health Organization (WHO) and the U.S. Environmental Protection Agency (USEPA) develop human health risk values (HHRV) that set ‘safe’ levels of exposure to non-carcinogens. Here, we analyze HHRV from the following organizations: USEPA, WHO, Health Canada, RIVM (Netherlands), and the U.S. Agency for Toxic Substances and Disease Registry. Using a Bayesian Network Analysis (BNA), the probability of the HHRV agreeing across organizations has been explicitly evaluated. This BNA was built using expert judgment and includes the specific science policy choices analysis made in the context of setting HHRV, including the selection of principal study, critical effect, the point of departure (POD) approach and numerical estimate, and the use of uncertainty factors (UF). Based on a preliminary analysis, there are differences between how these choices impact the likelihood of HHRV agreement. For example, if all choices agree except the POD there is a greater chance of HHRV agreement compared to the scenario where all choices except the UF agree. Based on a sensitivity to findings analysis, HHRV agreement is most sensitive to the POD value, followed by the UF, the critical effect, principal study, animal model, and POD approach. This analysis also considers the specific impacts of individual UF, with the database UF and the subchronic-to-chronic UF being identified as primary drivers of the UF differences observed across organizations. Limitations of this analysis include the small number of organizational comparisons (N=172), with future work planned to further evaluate the BNA model using additional comparisons and potentially case testing using expert analysis. (The opinions are those of the authors and do not necessarily reflect policies of USEPA or the U.S. government.)

Modeling Emergency Response Notification Tool in Response to Chemical Releases

Significant quantities of hazardous chemicals are stored near and transported through the maritime domain, over which the United States Coast Guard (USCG) has responsibility. The USCG assesses the risk associated with potential chemical releases and their impacts on human populations to aid in planning and operations. Such releases create hazardous situations with high potential for death and injury consequences. Studies of early warning systems enable modeling and simulation of the effects of such systems on a population to avoid death and injury due to chemical exposure. Chemical release scenarios and early warning systems include two key modeling elements. First, a simulation of a chemical release using geospatial data to model the spread of a chemical release cloud over time, space and populations. Secondly, simulation of the impacts of various early warning systems (e.g., sirens, tone-alert radios, media, telephones) over time include the activation of the signal, propagation of the warning message over a population, and the actual actions of people to evacuate or shelter-in-place. The simulation parameters are chemical behavior, warning message time, recommendation, and diffusions rate, chemical warning properties (e.g., irritant, odor), incapacitation potential, population distribution, uncertainty in warning message compliance, and evacuation time. This presentation includes the simulation and ensuing analysis associated with modeling a chemical release and the impacts of various emergency notification systems on equivalent fatality totals. The model utilizes a specialized tool leveraging GIS technology, population data, chemical dispersion modeling, and emergency signal modeling.
Development and Application of Simplified Damage Charts for Chemical Containers

The United States Coast Guard (USCG) implements an annual maritime terrorism risk analysis process, drawing on field analysts’ judgments to acquire maritime data. Field analysts use the Maritime Security Risk Analysis Model (MSRAM) to capture port level targets and analyze risks. The timely evaluation of risk requires simplified tools that can estimate the consequences resulting from defined threats and the ability of a target to withstand the threat. The USCG tasked ABS Consulting with investigating the effects of Improvised Explosive Devices (IEDs) on chemical storage tanks and transport vessels within the maritime domain. While the focus of the study is on the intentional application of IEDs, we have shown that the modeling is applicable to accidental explosions. The team developed simplified damage charts for chemical containers, derived from high-fidelity models using advanced finite element and computational fluid dynamics blast modeling techniques. A variety of chemical tank types is evaluated in order to cover the wide range of storage configurations. Examples include horizontal, vertical, and spherical tanks containing pressurized, refrigerated or ambient pressure material. The study addresses the general response of tanks and pressure vessels subjected to hand-carried, vehicle and vessel-borne explosive devices. The presentation will conclude with a comparison of the modeling completed in this study with the actual damage experienced in the accidental West, TX Ammonium Nitrate explosion.

Dermal Risk Assessment and Hand to Mouth Transfer Efficiencies

Although there are available risk assessment guidelines that provide a framework for assessing the risk potential associated with hand-to-mouth exposure to chemicals, a number of risk assessment approaches for incorporating the risk of hand to mouth exposure potential have not been based on empirical data or have been based on data from a surrogate chemical with unknown relevance to a specific scenario of interest. A discussion of the data available to address hand to mouth exposure in risk assessments will be provided, including for metals and pesticides, and data from a recent study on hand to mouth exposure potential for lead will be presented.

Public perceptions of extreme heat vulnerability in the U.S.

Extreme heat causes greater mortality and morbidity than any other weather-related hazard in the U.S. Particularly in cities, where urban heat islands exacerbate the intensity of summer heat events, extreme heat is a major threat to human health and presents a major source of societal vulnerability to climate change. Extreme heat is also one of the most clearly attributable hazards associated with climate change, and individual extreme heat events can serve as “teachable moments” about the future impacts of climate change, which will increase the magnitude and frequency of extreme heat events. People in different regions of the U.S. are differentially vulnerable to extreme heat, due to variations in climate and individual and community-level adaptive capacity. In addition, National Weather Service (NWS) definitions of extreme heat events vary substantially across the country due to variations in local adaptive capacity. However, there has been little research on how Americans perceive their own risks and abilities to cope with extreme heat, and on how such risk perceptions vary geographically in relation to physical exposure to extreme heat. Using a nationally representative survey (n=1,657) of the U.S. public conducted in 2013, this project examines geographic patterns of public perceptions of extreme heat at the national and local scale and investigates the relationship between objective exposure and subjective vulnerability. By associating local weather and climate data with each respondent, we characterize the local conditions that respondents consider to be extreme, their relationship with local NWS definitions of extreme heat, and the role of personal experience with extreme heat in subjective risk perceptions.

Quantifying the relationship between hemagglutination inhibition (HI) titer and protection against influenza

The objective of this research is to evaluate the relationship between HI titer in the host and the protection against influenza using modeling approaches. We expect that the respective exposure and subjective vulnerability. By associating local weather and climate data with each respondent, we characterize the local conditions that respondents consider to be extreme, their relationship with local NWS definitions of extreme heat, and the role of personal experience with extreme heat in subjective risk perceptions.
Re-assessing the affect heuristic: Trust and emotions as important ingredients to informed decision making about risks

Studies in the field of technology acceptance and risk perception have suggested that when citizens have little opportunity to deliberate about a technology, they base their opinion about the technology on affect or emotions (the so-called affect-heuristic; Slovic et al., 2004, Alhakami and Slovic, 1994). Similarly, trust, which has been called a social emotion (e.g. Cvetkovich and Winter, 2007), has been found to influence not only the affective but also the cognitive aspect of technology acceptance of people that rate themselves to have little knowledge of (Siegrist and Cvetkovich, 2000). Emotions and trust are in these cases portrayed as unreflected heuristics. Following this line of thought, we suggest that emotions and trust are important ingredients to informed decision making about risky technologies, independent of or even thanks to the availability of more knowledge, a significantly stronger correlation existed between trust or emotions measurements and people’s evaluations of the technology. Following these alternative hypothesis, we tested our hypothesis for the case of hydrogen fuel station acceptance by measuring attitudes towards the technology, risk and benefit perception, self-rated and tested knowledge and by including an experimental condition ‘information’. We tested for interaction effects between trust and emotions on the one hand and knowledge and information on the other hand. The findings did not support the alternative hypothesis. On the contrary, a part of the analysis revealed that when people had the most knowledge, a significantly stronger correlation existed between trust and emotions measurements and people’s evaluations of the technology. Following these alternative hypothesis, we propose a different view on the role of emotions and trust in decision making about risky technologies, independent of or even thanks to the availability of more knowledge. Emotions are crucial to moral and practical decision making (see also Damasio, 1994), which also plays a role in evaluating risky technologies (Roeser, 2012).
M3-I.4 Jayjock, MA; Armstrong, T*; Jayjock-Associates LLC; mjayjock@gmail.com

Risk Initiative: Lessons Learned

A group of about 3 dozen individuals with standing and interest in the process of determining and using Occupational Exposure Limits were identified in an open process. These folks were then invited to a series of teleconferences to discuss and present on the general premise of the initiative’s starting position: Any OEL established with full documentation should have the putative quantitative level of risk at that OEL estimated along with the uncertainty associated with that estimation. This presentation will summarize the main points of the various presentations and discussions along with insights as to lessons learned and what may be the next steps for this activity.

M2-C.3 Jessup, A*; Sertkaya, A; Wong, H; U.S. DHHS, Office of the Assistant Secretary for Planning and Evaluation; amber.jessup@hhs.gov

Analysis of Barriers to Clinical Trials on Drugs

Improving the drug development process, especially by conducting better (meaning providing more information on safety or efficacy) and faster clinical trials, can foster innovation in medical product development. Therefore, it is important to identify costs, efficiencies, and hurdles throughout the clinical trial process. At present, the major obstacles to conducting clinical trials in the United States include: high financial cost, the lengthy time frames, difficulties in recruitment and retention of participants, insufficiencies in the clinical research workforce, drug sponsor-imposed barriers; regulatory and administrative barriers, the disconnect between clinical research and medical care, and barriers related to the globalization of clinical research. In this study, we examine a number of barrier mitigation strategies ranging from the use of electronic health records (HER) to improvements in FDA review process efficiency.

W1-F.4 Jimenez, R.B.*, Blazquez, C.; Andres Bello University, Chile; rjimenez@unab.cl

Exploring inequalities in environmental hazard exposure: The case of Santiago, Chile

The spatial distribution of environmental impacts and hazards is, to a large extent, determined by geographic locations of industrial facilities and other pollutant activities in relation to the potentially exposed population. Over recent decades, researchers, regulators and the community have placed special interest on the accumulation of such environmental impact over vulnerable groups of the population, especially within urban areas. In this study, we explored potential inequalities in public exposure to environmental hazards from pollutant activities in Santiago, Chile. First, significant sources of environmental hazards in Central Santiago were identified and geocoded. We considered pollutant activities, industrial facilities and major roads within the study area. Consequently, we assessed population’s proximity to environmental hazard sources as a proxy for exposure. Using the ArcGIS software, we computed buffers around major environmental pollution sources within the study area, in order to estimate the distance from the centroid of each census block to environmental hazards. Buffer sizes varied according to attributes of pollutant sources, in order to better represent differences in hazards magnitude and spatial extension. Once the spatial distribution and accumulation of environmental hazards was georeferenced, sociodemographic characteristics of the exposed population were analyzed, including socioeconomic status, age, gender, and ethnicity. Our results show significant variability in population exposure to multiple environmental hazards across the study area, evidencing strong socioeconomic inequalities. Further implications for land use planning, environmental regulations, and related decision making processes are discussed.

W2-D.4 John, R S*; Nguyen, K; Rosoff, H R; University of Southern California; richardj@usc.edu

Application of MAU to obtain public trade-offs in aviation security screening

The current study aimed at capturing public trade-offs for various conflicting objectives related to air transportation security. Misunderstanding public concerns about security policies can have real and serious consequences on policies aimed at reducing terrorism risks. The current study was designed to assess trade-offs among five conflicting objectives: equity, aviation safety, screening hassle, wait time, and monetary costs, all relevant to passenger screening measures at airports. Two-hundred and twenty-two respondents completed the study online. They completed trade-off assessments involving all ten pairs of the five objectives. We employed an indifference procedure using sequential binary choices to assess travelers’ trade-offs among the objectives. Furthermore, the majority of respondents were not willing to pay more, wait longer, reduce safety, or endure more hassle to avoid inequitable screening procedures. Trade-offs were dependent on both sex of the respondent and their frequency of flying. We also examined how different methods of selecting travelers for further scrutiny influenced travelers’ trade-offs involving equity. Respondents were randomly assigned to one of three secondary screening conditions in which passengers are selected: (1) randomly, (2) using behavioral indicators, or (3) based on racial/ethnic profiling. Interestingly, equity was perceived as a somewhat greater concern when the method of selection was racial profiling compared to when it was randomized or based on behavioral selections. These findings suggest practical implications for airport security measures. Methodologically, our study exemplified the possibility of obtaining public trade-offs in a large representative sample at a small cost. Our methodological approach also attenuated the insensitivity to range effects found in previous research. Substantively, the results suggest practical implications for policy makers in prioritizing public values in policy design.
Occupational health data and their role in the development of the Integrated Science Assessments

As part of the reviews of the National Ambient Air Quality Standards (NAAQS) for the six criteria air pollutants, the U.S. EPA developed Integrated Science Assessments (ISAs) which provide a concise review and synthesis of the scientific literature related to the health effects associated with exposure to a given pollutant. The development of these assessments involves the integration of three complementary lines of health evidence, namely, epidemiologic investigations, animal toxicological testing, and studies of controlled human exposures. Over the past decade, the EPA has continuously improved the ISA development process, which is now presented as a preamble to each ISA, in order to increase transparency and consistency in the process of evaluating individual study quality and integrating the evidence across scientific disciplines and study types. Although the evaluation criteria presented may be applied to any type of scientific study, the “policy relevance” of occupational health studies is not explicitly addressed. Occupationally exposed populations often do not include those individuals at greatest risk of a pollutant-related health effect, and occupational inhalation exposures differ in many respects from exposures to ambient air pollutant concentrations and other pollutant mixtures experienced by the general public. This work presents a review and analysis of occupational health data considered during the development of the most recently published ISAs, as well as a discussion of the relevance of occupational data to inform conclusions related to associations between ambient air pollutant exposures and various health effects. Disclaimer: The views expressed are those of the authors and do not necessarily represent the views or policies of the National Institute for Occupational Safety and Health or the U.S. Environmental Protection Agency.

Does trust or distrust persevere over repeated events?: An exploration of trust asymmetry research to homogeneous event sequences involving management of nano-medicines

The trust asymmetry hypothesis is that trust is easy to lose but hard to regain. Johnson et al. (2014) found that repeated events involving management of nano-medicines were not perceived as a deterioration of trust. The trust asymmetry hypothesis is that trust is easy to lose but hard to regain. Johnson et al. (2014) found that repeated events involving management of nano-medicines were not perceived as a deterioration of trust. However, the trust asymmetry hypothesis is that trust is easy to lose but hard to regain. Johnson et al. (2014) found that repeated events involving management of nano-medicines were not perceived as a deterioration of trust.

Modelling terrorism risk exposure: The frequency conundrum

Modelling risk exposure for terrorism insurance products is an extremely challenging area subject to regulation and potential for significant loss. It is generally believed that there is insufficient data for accurate risk assessment. Theoretical models fail to capture the full range of scenarios and provide only a rough estimate of exposure. Government reports and back-up have actually stalled development of better models, by removing motivation to better understand the risk. Key issues within modelling are: definitions of what counts as terrorism, targets, attack types, impacts, frequencies, repeat attacks, CBRN/WMD and risk accumulation. As an anthropogenic threat, the lack of a clear definition of terrorism makes it difficult to model accurately. The trust asymmetry hypothesis is that trust is easy to lose but hard to regain. Johnson et al. (2014) found that repeated events involving management of nano-medicines were not perceived as a deterioration of trust.
Understanding the Channels of Contagion: A Game between Borrower and Lender Countries

Financial crises are increasingly global in nature. Recent crises, including the global financial crisis and the European debt crisis, have driven concern over how adverse economic events spread across countries and regions. The spread of crises, a phenomenon known as contagion, contributes to risk to economic stability. The mechanism by which contagion occurs, however, remains a topic of discussion. Contagion can be attributed to either trade or debt channels that can transmit adverse shocks between countries. Alternatively, simultaneous adverse shocks can be experienced in multiple countries due to a common cause, creating the same effect as contagion. We use a multi-agent model of borrower and lender countries to capture the transmission of shocks through trade and debt channels. Simulation and sensitivity analysis are used to illustrate how a negative event in one borrower country can lead to a crisis in another country. We also explore the possibility of common-cause shocks that lead to crises without contagion. Through this model, we aim to shed light on how crises may spread across countries through the rational behavior of borrower and lender countries. Although this work may give some insight into how crises can be managed, more work is needed to address recent financial crises and assess whether they have been caused by contagion or common cause failures.

Role of cognitive biases in perception of risks related to fracking

The contribution explores the role of the cognitive factors and biases in perception of risks related to fracking (hydraulic fracturing) technology, targeting primarily Germany and the EU. Possible role of about 20 major possible biases (such as those related to confirmation, authority, loss aversion, conjunction fallacy, decision fatigue, sleeper effect, implicit association, etc.) has been analyzed on the sample of about 500 answers obtained in the survey performed in early 2014 in the framework of a German national project Energy-Trans. A hierarchy of biases is proposed and their link to other non-cognitive factors (e.g. those proposed by IRGC or INTeG-Risk project) analyzed. The exercise shows that the cognitive factors can provide an important contribution to the process of quantitative assessment of the possible shifts of perception of risks related fracking and explain the gap between the perceived and “real” risk. The “real” risks were assumed to be those provided by the numerous scientific reports recently published on this issues. About 50 reports have been analyzed, both manually and by means of the semantic analysis, resulting in a large scatter. Therefore, one can hardly speak of “one real risk perception”. The gap between the real and perceived risks is, hence, is the distance between two clusters of assessment points, dynamically changing in time. The results show that cognitive biases should be considered in conjunction with other factors that they could help in better explanation the peaks in risks perception (identified and explored by means of analysis of social media) and that their role increases with the increase of uncertainty, ambiguity and complexity involved in risk assessment. This all is the case perception of fracking related risks and in this particular case the work has shown that the analysis of cognitive biases can predict the trend of change in risk perception and better explain the hysteresis and attenuation of this change.
Multi-factor exposures involving combinations of threshold and non-threshold mechanisms present a proposed risk assessment approach for addressing responses controlled by differing mechanisms of action and for a presumed linear no-threshold response for a classic effect of smoking and asbestos exposure requires accounting for presumed types of dose-response. Modeling the synergistic effects of smoking and asbestos exposure requires accounting for a threshold concentration below where risks are not modulated. Smoking and asbestos exposure appears to be more-than-additive with respect to risk, but only when exposures to both are substantial. Modeling multi-factor risks is particularly challenging when they operate via different mechanisms of action related to the asbestos, including a very low or no threshold type of immunogenic mechanism and clearly threshold-type repeated injury mechanisms. This presentation will discuss interactions occurring between mechanisms controlled by differing mechanisms of action and present a proposed risk assessment approach for addressing multi-factor exposures involving combinations of threshold and non-threshold effects.

Adaptive Management and Governance Challenges

This presentation opens the symposium with an overview of Adaptive Management, a structured decision-making process using multiple steps and iterations that is covered under Administrative Law directing select Federal Agency regulation and management of systems. We highlight the use of this management process as relates to natural resource and environmental systems, including remediation. This process is relatively new, and has had mixed success, with highly variable outcomes; it has proven to be much harder in practice than envisioned by the original theorists. We report on a new proposal in the legal community for improving the outcomes of Adaptive Management that is designed to allow true flexibility and more effective public participation and judicial oversight. We offer reactions from the legal community and federal agencies to the proposal and summarize the current problems encountered in implementing Adaptive Management as currently defined and interpreted. Given the required use of Adaptive Management and its ties to risk and decision-making under uncertainty, this topic will be of broad interest to risk analysts and scholars in governance, law, policy development, regulatory science, economics, ecology, and natural resource management.

Overview of research on residential wood smoke-associated health effects in economically developed regions

High exposure to biomass-burning smoke contributes to the burden of disease in households that lack adequate means to ventilate smoke outdoors. Indoor biomass burning is known to lead to health problems in households with more adequate ventilation. In economically developed countries, moderately elevated smoke exposure is likely in households using fireplaces or leaky wood stoves. Even households with efficient wood stoves may have elevated indoor smoke concentrations, especially when stoves are improperly operated and when the smoke outside infiltrates back inside. This presentation gives overviews of the published time-series studies done in a few of the communities in the United States and New Zealand where residential wood-burning is a major source of airborne particulate matter, and of wood smoke-associated health effects research involving households with wood-burning devices in the United States, Russia, some European Union countries, and Canada. Collectively, these studies suggest exposure to residential wood smoke can result in harmful respiratory and cardiovascular effects: Asthma symptoms are most strongly associated with exposure. Hospitalization for chronic lung disease, acute respiratory infections and other respiratory conditions are also significantly associated with exposure. Hospitalization rates for conditions thought to be influenced by particulates or naturally occurring origins, together with the temporal dimension in which the potential hazard is presented (acute or chronic). This study presents a case study analysis to examine how these hazard characteristics affect people’s risk and benefit perceptions, and associated attitudes and behaviours. The cases include E.coli incidences (outbreaks linked to fresh spinach and fenugreek sprouts), contamination of fish by environmental pollutants, (organochlorine contaminants in farmed salmon), radioactive contamination of food following a nuclear accident (the Fukushima accident in Japan), and GM salmon destined for the human food chain. The analysis of the cases over the temporal dimension suggests that longitudinal quantification of the relationship between risk perceptions and impacts is important for both acute and chronic food safety, but this has infrequently been applied to chronic hazards. Technologies applied to food production tend to potentially be associated with higher levels of risk perception, linked to perceptions that the risk is unnatural. However, for some risks (for example those involving biological irreversibility) moral or ethical concerns may be more important determinants of consumer responses than risk or benefit perceptions. (Lack of) trust has been highlighted in all of the cases suggesting transparent and honest risk-benefit communication strategies, additional research linking risk perception and other quantitative measures, including comparisons in time and space, are suggested.
high throughput bio-response analysis reveals unique mode of toxicity of Cu nanoparticles

nanotechnology has grown rapidly over the past decade, promising benefits in diverse areas of society. however, the rate of technological development has outpaced the rate of development, leading to concerns over the potential ecological and environmental consequences of nanoparticles. here, we report the application of a dose-response analysis and a high-throughput suite of sub-lethal assays to a series of Cu particles, including CuO nano CuO, and CuOH2 micro CuO and micro CuO as well as ionic Cu (CuCl2 and CuSO4) in bacteria (Escherichia coli and Lactobacillus brevis). Fluorescent dose-response assays, including PI/SYTO, XTT, DiBAC, and H2DCFDA, were used to measure membrane damage, respiration rate, potential, and ROS production, respectively. Half-maximal inhibitory concentration (IC50) values were calculated from growth inhibition curves, revealing that CuO and CuO NPs are more toxic than their micro-sized counterparts, with toxicities approximating the fundamental failure mechanism of punching shear reinforcement. Flat plates consist of slabs directly supported by columns without beams. From a structural mechanics point of view, flat plates are complex structures. Studies have shown that punching shear failure is usually in brittle manner by punching at the slab-column connections within the discontinuity region. Investigations have been conducted to study this complex phenomenon of punching shear in reinforced concrete flat plates by trying to estimate the strength of shear failure using mechanical or purely empirical models. Despite the importance of these models to understand the mechanism of failure by punching, the complexity of their use is not justified by their precision. To compensate this problem, most design codes developed simple equations in which a nominal shear stress is calculated on a section critical to some distance from the column. Predictive modelling in structural engineering and compared to a known value. The classical empirical techniques used by many design codes show limited accuracy, so a more robust empirical modelling technique is needed that can resolve the uncertainties encountered in determining punching shear failure mechanisms. A new predictive design method is presented in this research work. This is a hybrid method for modelling, called neuro-fuzzy, it's based on neural networks with fuzzy learning. A total of 170 experimental data points obtained from concentric punching shear tests of reinforced concrete slab-column connections from the literature have been exploited by the model (113 for learning and 57 for validation) and confirmed by statistical validation criteria. Very satisfactory results were obtained from this assessment, and the results were compared to representative design codes from around the world. A parametric study of the main parameters affecting punching shear capacity approximates the fundamental failure mechanism of punching as described by several researchers.
T3-J.8 Kim, S-J*; Trumbo, CW; Colorado State University; kim.sage@gmail.com

Need for Affect and Cognition as Antecedents to Risk Perception, Information Processing, and Behavioral Intent

This study introduces and develops a hybrid theoretical model of risk-based attitude and behavioral intention based on the Theory of Reasoned Action (TRA), cognitive-affective Risk Perception, the Heuristic Systematic Model (HSM), need for affect (NFA) and need for cognition (NFC). The model proposes that personality attributes, information processing and risk perception are antecedents to the TRA and may be structured so as to provide both a cognitive and an affective path toward behavior (e.g., NFC --> systematic processing --> cognitive risk perception). Data to test the model come from two studies, one completed and the other pending. The completed study examined orientation toward the use of sunscreen containing nano-particles, the pending study (August 2014) will use an identical approach but will focus on genetically modified food. Both of these topics involve consumption behaviors involving a new innovation, but also differ in important ways. Data collection was conducted in spring 2014 using an online survey. Students were recruited from two university-required undergraduate classes in a western U.S. university. Of the 535 students recruited, 391 completed the survey (73%). Multi-item measures were utilized for each concept with good to excellent reliabilities. A path analysis was conducted demonstrating that need for cognition positively predicts systematic processing, cognitive risk perception, attitude toward act, and behavioral intention. Likewise, need for affect predicts heuristic processing and affective risk perception, which then predicts social norm, attitude, and intention. These findings offer general support for the proposed model. Further analyses divided the participants into groups having the joint characteristics of high NFC & NFA, low NFC & NFA, high NFC & low NFA, and low NFC & high NFA. These sub-analyses served to further refine interpretation of the overall modeling results.

P.112 Kim, S-J; Colorado State University; kim.sage@gmail.com

Utilizing Need for Affect and Cognition: Measuring Environmental Policy Preference by Experimental Design Studies

Previous studies reported that an affective message had stronger effects on attitude changes amongst those high in need for affect (NFA) and low in need for cognition (NFC). On the other hand, a cognitive message was found to elicit more positive changes in attitudes in those categorized as high in NFC and as low in NFA. Based on the review of the literature, the present study proposes several ways to more effectively utilize both NFA as well as NFC. Thus, this paper suggests H1: Individuals exposed to a cognitive message who are high in NFC and low in NFA will more likely to support an environmental policy issue, compared to individuals exposed to other messages (i.e. affective, both cognitive & affective, and neither cognitive nor affective messages); H2: Individuals exposed to an affective message who are low in NFC and high in NFA will more likely to support an environmental policy issue, compared to individuals exposed to other messages; H3: Individuals exposed to a combined (both cognitive and affective) message who are high in NFC and high in NFA will more likely to support an environmental policy issue, compared to individuals exposed to other messages; H 4: Individuals exposed to a neutral (neither cognitive nor affective) message who are low in NFC and low in NFA will more likely to support an environmental policy issue, compared to individuals exposed to other messages. In addition, this study adds involvement and endorser as moderators of these relationships; furthermore, it looks at opinion leadership on the climate change issue and behavior/intention towards the adoption of new E.P.A. carbon pollution regulations as additional dependent variables. A series of experimental design studies (Study 1, 2, and 3) will be introduced and each study’s findings will be discussed.

M2-G.1 Kirman, CR; Summit Toxicology, LLP; ckirman@summittoxicology.com

Collective wisdom technology, queries and demographics

This speaker will help the audience understand the proven technology being used for public participation during the workshop using their internet-enabled devices. Web-based forms will be used to elicit the opinions of the audience on the scientific topics covered in the mode of action sessions. Based on the input received, web-based reports will be generated and shared with the audience in real-time.

W4-E.5 kirman, cr*; meek, me; gray, gm; Summit Toxicology, LLP; ckirman@summittoxicology.com

Improving Transparency in Hazard Value Development

As chemical hazard and dose-response assessments increase in their complexity and robustness, the support documents can easily grow to several hundred pages in length. These assessments often include components (e.g., PBPK modeling, dose-response modeling, regression analyses of epidemiology data) that remain a “black box” to even seasoned risk assessors. For this reason, it becomes a challenge to present this information in a clear and concise manner to those who are applying the assessment to make a decision (i.e., risk managers). A successful dose-response summary will be able to distill the assessment down to key steps and decision points in a simple yet clear manner. To accomplish this goal, we have developed an example summary table that shows how to visually present the key information in a manner that that facilitates communication and prioritization of data needs. In electronic form this format can be readily extended to allow users to interact with the table by selecting alternative options to allow stakeholders, including risk assessors and risk managers, to see the impact that decision point changes have on the overall derived value. This presentation will show this tool and explain with specific examples how the elements and the tool can help inform not only individual assessments, but also serve to make comparisons across multiple hazard assessments.

December 7-10, 2014 - Denver, CO
Addressing potential risks of emerging technologies: a comparative study on responsible innovation

Ensuring the safety of emerging technologies besides consideration of costs and functions has become essential for the market since in the course of commercialization, each emerging technology inevitably faces the demand of business customers or consumers for the evidence of safety. Safety concern can be one of the obstacles that hinder innovation. Generally, to avoid this, specific risk assessment methods are developed and conducted to show that the actual risk of the certain emerging technology is below the predetermined acceptable risk. However, actual innovation process does not proceed in such an ideal way. This study takes three examples, carbon nanotubes, healthcare robotics, and hydrogen stations and explores how the safety aspects were addressed or being addressed in the course of R&D and commercialization in Japan through literature reviews and personal interviews. The role of stakeholders, in particular the commercialization in Japan through literature reviews and personal interviews. The role of stakeholders, in particular the

Investigation of the efficacy of skin decontamination by washing

Washing with soap and water is generally presumed effective in removing chemical contaminants from skin and is an essential component of both occupational and personal hygiene. However, only limited experimental investigations directly addressing chemical decontamination by washing with soap and water have actually been conducted (although a considerably larger number of dermal absorption experiments involving washing at termination provide some information). In addition, no theoretically robust model of washing has been presented and warnings have even been raised that washing might even increase dose via "wash-in." Further investigation of washing phenomena is therefore warranted. Relevant activities have been conducted. They involve 1) in vivo human experiments using DEET as a surrogate compound and 2) development of a skin-washing model. Experiments (n=72) have been conducted in which DEET was applied to forearms at two surface loads (5 and 30 µg/cm²). After a delay of 10 or 40 minutes, skin was washed with water alone, soap and water, or ethanol and water. Twenty-four hour urine samples were collected for up to five days to permit biomonitoring of excreted DEET metabolites. Complimentary modeling efforts involve simulation of one-dimensional transport in a two-layer membrane (stratum corneum and viable epidermis) by finite differences approximation. Description of water transport in the skin incorporates hydration and swelling of the stratum corneum, and concentration dependent diffusion.

Structural Models of Japanese Public Perception regarding the Risk of Radioactive Substances in Food

The problem of food contamination due to radioactive substances derived from the Fukushima nuclear accident has highlighted the importance of risk communication. Many Japanese people are anxious about the health effects of radioactive substances and regard the government and media with distrust. Some refrain from buying food products from Fukushima and neighboring areas, even if the concentration of radioactive substances is within legal limits. This situation requires risk communication while representing a challenging environment for risk communication. In order to conduct effective risk communication to establish mutual understanding, it is necessary to understand public risk perception and the background factors underlying these perceptions or behaviors. This study was aimed at examining the perception of the Japanese public toward the risk of radioactive substances in food and identifying the structure of their perception and the background factors of their perception and behavior. We conducted three internet surveys in Japan from May 2011 until February 2012. The survey contents were based on the psychometric approach and consisted of perceived risks, risk characteristics, and items in a personal and social context. Structural models composed of causal relationships among perceived risk and other factors were estimated by structural equation modeling. Results showed that "negative images of risk" had a major effect on perceived "severity of health effects," which in turn determined the perceived magnitude of risk, while "knowledge" had little effect on the perceived risk. "Trust" in government and experts was found to have a strong impact on the perception that risk is lower until radiation doses reach a certain level, which slightly lowered the level of perceived risk. It was also found that the purchasing behavior of participants could be explained to some extent by "perceived personal risk," "knowledge," "severity of health effects," and "trust."

Climate of doubt: Media and elite framing in North Carolina’s passage of House Bill 819

In 2012, North Carolina passed House Bill 819, which put in place a four-year moratorium on the calculation of future sea level change, as well as related policy implementation. The bill was a response to a 2010 report published by the state’s Coastal Resource Commission’s Science Panel, which stated that the coast of North Carolina is highly likely to experience a one meter sea level rise by 2100. The bill led to media frenzy, especially in Raleigh, North Carolina, where the political debate was centered. The NC legislatures action highlights the doubt that persists surrounding climate and sea level change nationally. A central aspect of this debate is how does the media frame climate change. This leads to the central question of this research project how did the Raleigh media frame climate change, sea level rise and the arguments of various actors involved in the bill’s debate? We answered this question by examining climate change coverage in the city’s newspaper, The Raleigh News and Observer, and publications of the NC based conservative think tank, the John Locke Foundation. Our analysis found that due to their different audiences and political stances, the two sources addressed the bill and environmental conditions in very different ways, reflecting a political polarization in the media.
Climate risks over space and time: Prospects for improving estimates of global climate change damages with data-based physical projections and more robust impact functions

Estimates of the aggregate global economic risks associated with climate change have traditionally relied on simple benefit-cost integrated assessment models (IAMs). These IAMs use reduced-form representations of global energy balance and carbon cycling to project the change in global mean temperature forced by anthropogenic greenhouse gases. They employ reduced-form damage functions (sometimes obscurely calibrated) to translate global mean temperature changes to dollar- or welfare-denominated damages. Yet the effects of global climate change are manifest through their effects on local climate, not just on global average temperature; the consequences of climate change differ for the U.S. Northwest and the U.S. Southeast. Moreover, these effects include not just changes in the mean climate state but also shifts in the frequency of extreme events. For example, in many places, the most devastating effects of sea-level rise are realized through the changed in the distribution of storm flood levels, not permanent inundation. Coupling downscaled global climate model projections to empirical estimates of the responses of economically-relevant impacts such as crop yield and labor productivity provides a path forward for assessing both the regional distribution of climate impacts and the effects of interactions between climatic variability and a changing mean state. We illustrate the approach with an application to the United States and highlight directions for extension of our framework to global scale.

W3-K.1 Kovacs, D; Thorne, S; Butte, G; Decision Partners; dkovacs@decisionpartners.com
Applying Mental Modeling Technology™ to Support Stakeholder Engagement for the Census Bureau’s American Community Survey through Research with Individuals Who Work Closely with ACS Stakeholders

The U.S. Census Bureau (CB) serves as the leading source of quality data and information about the nation’s people, places, and economy. The CB’s American Community Survey (ACS) is an ongoing survey of 3.5 million households each year, and is one of our nation’s most important information-gathering tools. Data collected through this survey provide a comprehensive picture of the residents in the United States, and the places and the economy in which they live. ACS data have a tremendous impact on our lives, informing and driving decisions about improvements to roads and public transportation systems, ways to support schools and hospitals, economic growth strategies, need for emergency services, tactics for disaster recovery, and much more. Despite the many vital uses of ACS data, many respondents are not aware of the survey’s or its value, and some respondents are opposed to completing the survey because they find the questions intrusive or burdensome. Many people who could use ACS data to improve their businesses and organizations may not know what is available to them and how to use it. This lack of awareness of and resistance to the ACS potentially limits its impact and benefit to the nation. As part of a larger project to overcome these challenges CB sponsored Mental Models Research with individuals who could provide the greatest interaction with ACS Respondents and data users. Building on previous research an Expert Model of “Influences on Key Stakeholder Decision Making on ACS Data Collection and Dissemination” was developed and used as the analytic basis to produce an interview protocol. In-depth mental models interviews were conducted with 25 individuals from CB regional offices, State Data Centers, and Census Information Centers. The resulting interviews provided critical insight to ACS data collection and dissemination activities in order to produce recommendations to support regional communications and improve outreach to external audiences.

P.127 Kowalek, D; Howard University; denna.kowalek@gmail.com
#Hurricane Sandy: An analysis of Instagram photos using the CAUSE Model to determine Risk Communication Practices

With new emerging technologies, the way we receive our information has changed. Social media is no exception. Communication is more likely to save lives during a disaster than any other form of intervention. Examining Instagram posts during Hurricane Sandy in the fall of 2012 allows risk communicators to determine how users perceived the impending storm and determine the precautionary and preparedness actions taken by Instagram users. Understanding how people viewed Hurricane Sandy through Instagram will help generate more effective risk communication campaigns to be disseminated throughout Instagram and other similar forms of social media. The research will focus on determining the goals users had when they posted the Instagram photo listed under the hashtag #hurricane sandy is coming. This research will utilize Rowan’s et al. (2009) CAUSE model as a framework to analyze the image in order to understand how Instagram users perceived the impending threat of Hurricane Sandy. This will be done to determine how Instagram users used this form of social media during a natural disaster. This information is crucial in order to understand how Instagram users discussed the hurricane with others, and how users shared precautionary and preparedness actions with others. A content analysis will be conducted of messages from the social media website Instagram to understand how users addressed the storm before it made landfall in New York and New Jersey in October of 2012. The hashtag analyzed, #hurricane sandy is coming yields posts that were produced before the storm, therefore coinciding with risk communication. This research will provide further implications regarding how Instagram and other forms of social media can be used to promote precautionary and preparedness actions during a disaster.

WITHDR. Korchevskiy, A; Chemistry & Industrial Hygiene, Inc.; akorchevskiy@c-ih.com
Evaluation and Validation of Lung Cancer Relative Risks from Asbestos Exposure Using Linear, Non-Linear, and Fiber-Specific Asbestos Risk Assessment Models

After several decades of intensive studies, there are still many questions associated with asbestos risk assessment models for lung cancer. It is important to review and compare different approaches to evaluation of relative risks based on various mathematical shapes of a dose-response curve. During the symposium, it will be demonstrated that lung cancer potency factors (as determined by works of Berman, Crump and Hodgson and Darnton) may be related to the fiber-specific characteristics, like shape, dimensions, and mineral type. Directions of further development of lung cancer models for different occupational, environmental and societal factors will be discussed.
Using Kaldor-Hicks Tableaus for Distributional Accounting in Regulatory Impact Assessment

The OMB recommends that agencies provide a separate description of the distributional effects of regulations in their regulatory impact assessments (RIAs). However, a review of recent RIAs shows that agencies rarely follow this analytical guidance. Our research assesses the feasibility of improving the representation of distributional effects in RIAs using the Kaldor-Hicks tableau (KHT) display format. In concept, a KHT disaggregates total benefits and costs and allocates them to stakeholders, and also records between-stakeholder financial transfers. The format provides a conceptually consistent display of distributional effects at a chosen level of stakeholder representation, revealing the effects on the “public stakeholder” as a fiscal impact assessment. To operationalize this concept, five final RIAs completed from 2011-2013 are chosen for detailed analysis, one from each of the DOT, EPA, DOL, HHS, and DHS. KHTs are constructed based on information presented in the regulatory impact assessments themselves, and assumptions about the tax status of the identified industrial sector subjected to the regulation. We show that it is feasible to construct KHTs for regulatory impact assessments from the data that is usually collected to produce them, and that this approach provides better insight about the distributional effects of regulations than current practice. Moreover, revealing the fiscal impact of regulations is relevant for the efficiency analysis, given the marginal value of public funds in the currently constrained environment.

Application of Food Defense Software Tools for the Purposes of Informing Intervention Strategies

Intentional foodborne contaminations have been attempted in the United States and abroad. As part of the Terrorism Risk Assessment efforts for DHS, software tools capable of assessing various threats to the U.S. food supply from “farm-to-fork” have been developed. Such, quantitative software tools for food defense can be used to prioritize strategic initiatives, as well as operational activities, in a manner that quantifies benefits for decision makers. The purpose of this study was to identify opportunities for strategic investments and initiatives to reduce risk by better understanding the potential impact of key aspects, specifically the speed of intervention strategies (e.g., a recall, advisory, or warning) and the compliance of both consumers and retailers with interventions. Through collaboration with NCFPD and DHS OHA, the universe of food scenarios was condensed to combinations of representative food clusters and toxidromes (i.e., a group of chemicals resulting in similar human health effects and requiring similar medical treatments). Quantitative mathematical models were then constructed for exemplar foods within each cluster based on an extensive data gathering effort involving the USDA, the FDA, trade associations, and food industry. Model results were generated for a representative chemical within each toxidrome to reflect the food cluster-toxidrome combination. Simulations for each cluster-toxidrome combination were performed using current baseline capabilities, as well as alternate conditions to assess the impact on consequences of faster investigation timelines and enhanced intervention compliance. Comparison of results for simulations indicate key areas where improved diagnostics, early warning systems based on public health data, public education for recognition of foodborne illness, and social media to spread information can significantly impact the potential human health consequence of foodborne contamination scenarios.
T3-E.3 Kuiken, T*; Oye, K; Collins, J; Woodrow Wilson Center; todd.kuiken@wilsoncenter.org
Shaping Ecological Risk Research for Synthetic Biology
Synthetic biology is a field characterized by rapid rates of change and by the novelty, and breadth of applications. The rapid pace of synthetic biology research, product development, potential environmental release of numerous applications, and the diversity of its potential nature and diversity of uses has prompted renewed attention on how to design robust ecological risk research programs. With support from NSF’s Division of Cellular and Molecular Biology, the Division of Environmental Biology, and the Engineering Directorate, the Woodrow Wilson Center and the MIT Program on Emerging Technologies convened a series of workshops to identify gaps in knowledge on the ecological effects of synthetic biology, to define a research agenda to improve the scientific and technical understandings of these ecological effects and to provide input on research funding priorities. Varied applications were used to seed discussions among synthetic biologists, ecologists, environmental scientists, and social scientists, as well as representatives from government, the private sector, academia, environmental organizations and think tanks. Projects included nitrogen fixation by engineered crops, gene drive propagation in populations of invasive species, engineered seeds for glowing nitrogen fixation by engineered crops, gene drive propagation in populations of invasive species, engineered seeds for glowing

T3-C.4 Kurfirst, LS; Kanter, D*; Swanson, Martin & Bell; dkanter@snbtrials.com
Hazard v. Risk, Product Deselection and Relevant Law
There are many ways in which product deselection, or perhaps more accurately, product modification can occur. The more traditional approaches have been agency regulation and state wide or federal legislation. Generally speaking, each of these approaches can be characterized by a delay and a major difficulty in addressing these complex questions and overcoming the communications barriers across disciplines cannot be done on a short term basis. In addition a concomitant assessment of economic and social implications of applications would be needed to provide foundations for assessing the ecological implications of synthetic biology.

T2-K.1 Kuttschreuter, M; University of Twente, Netherlands; margot.kuttschreuter@utwente.nl
Understanding protective behaviour and information seeking regarding the risks of Lyme disease to ones child
In recent years, the number of ticks in the Netherlands has increased, and so has the incidence of Lyme disease. This called for initiatives to inform the public about the risks and effective protective behaviour. This is especially necessary for young children, the group at highest risk. This study investigated parents’ actions to protect their children against Lyme disease, and on what motivates them to take notice of messages related to their risk to their children. A cross-sectional survey has been carried out among parents of children under the age of 13 (n = 300). Based on the Protection Motivation Theory, the Risk Information Seeking and Processing model and the risk perception literature, parents were questioned regarding their knowledge of Lyme disease, their risk-related perceptions and anxieties, their risk-related behaviours, their motivation to be well informed and their information seeking behaviour. All variables were measured reliably. Factor analysis showed that the parents’ actions to protect their children against Lyme disease could be classified into two groups: precautionary behaviour aimed at reducing the likelihood of their children being tick bitten and post-exposure behaviour. Both precautionary and post-exposure behaviour correlated significantly with self-efficacy, risk sensitivity and perceived vulnerability, whereas only precautionary behaviour was significantly related to the relevance of Lyme disease to the parent’s life. Information seeking was found to be significantly related to the motivation to be well informed and informational subjective norms in particular. Structural equation modelling has been applied to better understand the relationship between precautionary behaviour, post-exposure behaviour and information seeking. Further research on the development and implications for risk communication will be discussed.

P.25 Kwagyr-Afful, EK*; Zhu, J; Brookmire, L;uccioli, S; U.S Food and Drug Administration; Ernest.Kwagyr-Afful@fda.hhs.gov
Public Health Implications of the Effect of Covariates on Food Allergen Dose Response Model
Food allergic responses are highly variable in severity, and doses that cause effects vary by several orders of magnitude among individuals. This is especially true for children, who are more likely to play outdoors and thus more vulnerable to contracting Lyme disease. In order to develop effective communication messages and strategies, knowledge is needed on parents’ perception of Lyme disease, and on what motivates them to take notice of messages related to their risk to their children. A cross-sectional survey has been carried out among parents of children under the age of 13 (n = 300). Based on the Protection Motivation Theory, the Risk Information Seeking and Processing model and the risk perception literature, parents were questioned regarding their knowledge of Lyme disease, their risk-related perceptions and anxieties, their risk-related behaviours, their motivation to be well informed and their information seeking behaviour. All variables were measured reliably. Factor analysis showed that the parents’ actions to protect their children against Lyme disease could be classified into two groups: precautionary behaviour aimed at reducing the likelihood of their children being tick bitten and post-exposure behaviour. Both precautionary and post-exposure behaviour correlated significantly with self-efficacy, risk sensitivity and perceived vulnerability, whereas only precautionary behaviour was significantly related to the relevance of Lyme disease to the parent’s life. Information seeking was found to be significantly related to the motivation to be well informed and informational subjective norms in particular. Structural equation modelling has been applied to better understand the relationship between precautionary behaviour, post-exposure behaviour and information seeking. Further research on the development and implications for risk communication will be discussed.

P.35 Kveton, P*; Svoboda, P; Van Kemenade, C; Van Der Weele, J; Adema, R; De Leeuw, S; Mahseer, M; Piek, J; Oudejans, R; Van Vliet, R; Van den Brandt, P
December 7-10, 2014 - Denver, CO
P.96 López-Vázquez, E*; Marván, ML; Dorantes, G; Morelos Universidad Autónoma del Estado; espelva@mac.com

Experiencing flood evacuation and its impact on risk perception, stress, PTSD, and coping strategies

Among the climate changes that most affect our societies, one will find those that are caused by hydrometeorological phenomena. In Mexico, these types of events have been the kind that have caused the most ecological losses have caused in the last years. Studies show that experiencing a flood can influence in the perception of risk, causing said perceptions to bend towards the negative, especially in populations that have been affected by an event, when one compares other populations that have not experienced one first hand (Miceli, Sotgiu, Settanni, 2008). Therefore, our objective is to analyze the perception of risk in people that are exposed to floods has an influence in the type of coping strategies they use, the psychological stress they are subject to, and post traumatic stress disorder (PTSD), if they have experienced an evacuation or not. It is also an objective of this study to verify if the psychological stress and the occurrence of PTSD has an influence in the coping strategies used in both situations. Sample was comprised of 164 individuals evaluated through 4 different scales (risk perception, psychological stress, PTSD, and coping strategies). This study found that there are more individuals with PTSD in the group of the people that evacuated than those that did not do so; when correlations are carried out between stress and PTSD we can verify that they might act positively because when these are higher, there is also a higher level of active coping. If one observes the individuals that have not evacuated, one will observe that risk perception, psychological stress and PTSD are correlated with active coping and passive coping, showing a flexible coping strategies that could be more appropriate while facing stressing situations.

T3-E.4 Lombertini, E*; Buchanan, RL; Narrod, C; Pradhan, AK; University of Maryland, College Park; eliam@umd.edu

Transfer of zoonotic pathogens in the household environment by direct surface contact

Recent Salmonella outbreaks associated with handling dry pet food highlight the importance of this product as potential vehicle for introducing zoonotic pathogens into the household. The risk of exposure associated with product handling practices and subsequent patterns of interaction with household surfaces, pets, human food, and other humans is not well understood. As a result, the existing guidelines to prevent exposure are not based on quantitative estimates. This study aims to: 1) model the spread and transfer of Salmonella, introduced with dry pet food, through the household environment, 2) estimate the role of pets in spreading pet food-borne Salmonella in the household and to humans, and 3) assess the impact of mitigation strategies on exposure risk. A systematic literature review was used to collect data on Salmonella contamination levels in dry pet food, bacterial ecology on food and surfaces, and transfer by contact. A probabilistic Monte Carlo simulation model was developed to estimate Salmonella spread in the kitchen, living/dining room, bathroom, and on floors. Mitigation options considered include alternative pet feeding practices, hand washing, cleaning surfaces with antimicrobial solutions, washing fabric, and controlling pet access to sensitive areas. The model was run for two main scenarios: (a) a pet feeding event and immediately subsequent actions, (b) the course of an entire day including multiple pet feeding events, food preparation sessions, and repeated interaction with household surfaces. Model outcomes are expressed as prevalence and concentration of Salmonella on each household surface at the end of the scenario, and as probability of illness associated with touching a contaminated surface or ingesting cross-contaminated food. This model provides a tool for risk communication and the development of quantitative risk-based mitigation guidelines.

T3-C.2 Lambert, JH; University of Virginia; lambert@virginia.edu

How Risk Analysis Should Influence Priorities in Infrastructure Management and Investment

Risk analysis has an evolving role in infrastructure management and investment. This presentation will consider risk as an influence of scenarios to priority-setting. Scenarios will be described as compositions of emergent and future conditions, including economics/markets, technologies, environment/ecology, regulations, behaviors of populations and workforces, etc. Priority-setting will be distinguished from decision analysis, decision aiding, decision making, and policy making. Priority-setting will be described as fundamental to risk programs. Risk programs will be described as integrating various activities of risk assessment, risk management, and risk communication. Risk programs will be shown to address three questions: (i) What is the scope of risks to be addressed in the program; (ii) What are the allocations of program resources across locations, organizations, populations, time horizons, sources of risk, manifestations of consequences, etc.; and (iii) What is the monitoring of program efficacy into the future. Several dozen canonical aims of risk programs will be identified. Illustrative examples will be presented from the domains of energy, transportation, emergency management, and the research enterprise.

T4-F.5 Landis, WG; Western Washington University; wayne.landis@wwu.edu

Incorporating the reality of climate change into risk assessment, remediation, and the long-term management of ecosystem services.

The reality of climate change and its implications alters the paradigm currently in place for the risk assessment of contaminates and other stressors. Here are a few examples. 1) Climate change is not a future event but has already altered arctic, marine, freshwater, agricultural, forest and other environments. Temperature, precipitation amount and type, the acidity of nearshore environments, growing seasons and species distributions have been altered. Therefore planning using the last 40 years as a “natural” baseline is invalid as an indicator of future variation around a mean. 2) Conditions at legacy sites are different than in the past and will continue to change in the future even without any effects due to the contaminants or the management activities. It will be a challenge to design monitoring programs that can differentiate between the effects of an altered climate and the simultaneous restoration and management activities. 3) An altered climate will alter the type of ecosystem services available therefore altering the specific types of endpoints being evaluated. It will be necessary to use multiple endpoints that may change as the environment is altered to describe adequately the ecosystem services. These three items also require that long-term environmental resource extraction such as mining, agriculture, and the building of port facilities will require an adaptive management strategy that actively plans decades in advance. NPDES permitting, CERCLA remediation, and NRDA planning will have to accommodate these realities if they are to meet their goals of ensuring water quality, the remediation of contaminated sites and recovering damages. Although a novel situation, current tools such as the relative risk model and similar approaches can incorporate climate change and examples will be presented.
How dose response curves derived from clinical ozone exposures can inform public policy

Ozone is one of the 6 criteria air pollutants whose levels are set by the US EPA through the National Ambient Air Quality Standards. Data from animal, human clinical and epidemiology studies are used to decide at which level to set the standard. The purpose of our work is to use data from human clinical studies to inform policy decisions about a protective ambient ozone level. Many studies have been conducted and can be applied to generate ozone dose-response curves, using ozone total inhaled dose (which is calculated from ozone concentration, duration of exposure and ventilation rate) and forced expiratory volume (FEV1) decrements. Outside of modeling done by the EPA, these dose response curves have not been utilized as tools to inform the choice of a protective ambient ozone concentration. In this work we plotted mean FEV1 response versus total inhaled ozone dose from clinical studies of varying durations (1 – 8 hours). Mode of action (MOA) information was incorporated as appropriate. The initial plot used data from healthy young adults, and additional analyses incorporated data from children and asthmatics to determine whether they differed from the healthy adult curve. The trend line from this data was employed to make tables demonstrating the ozone concentrations required to produce a given FEV1 decrement at different exposure times and ventilation rates (i.e. exercise levels). We also plotted ozone doses at which other relevant clinical effects occur (e.g. inflammation and airway hyper-responsiveness) although the variability in technique and lack of consistent quantification makes these difficult to model in a similar way as FEV1. We think that this type of analysis is crucial for deciding on a protective ambient ozone concentration, because differing levels have significant societal and economic implications. Clinical data provides quantifiable and confident endpoints that can be justifiably used for well-reasoned and scientifically credible rule making.

The Use of Cross-Species and Cross-Disciplinary Evidence in Support of Causality Determinations in the U.S. Environmental Protection Agency’s Integrated Science Assessment for Lead

The United States Environmental Protection Agency (US EPA) regulates six criteria air pollutants, including lead (Pb), by way of the National Ambient Air Quality Standards (NAAQS). To inform the NAAQS setting process, EPA produces Integrated Science Assessments (ISA) which contain a synthesis and evaluation of the most policy-relevant science that forms the scientific foundation for review of the NAAQS for human health and welfare. In the ISAs, EPA has developed a framework to assess the causal relationship between pollutant exposure and effects, which is based largely on the aspects for causality proposed by Sir Bradford Hill. In support of the Pb NAAQS, EPA conducted a cross-species evaluation of health effects and modes of action that provides a unique comparison of Pb exposures in humans, laboratory animals and wildlife. The persistence of Pb in the environment results in shared exposure among humans and other biota. The peer-reviewed epidemiologic, toxicological and ecological literature on effects of Pb indicates coherence of common effects and underlying key events within modes of action providing biological plausibility across multiple organisms for several endpoints: hematological effects, reproductive and developmental effects, and nervous system effects. Commonalities in effects and underlying key events strengthened biological plausibility for hematological effects assessed in the ISA for Pb. Some reproductive and developmental effects were common across human and ecological receptors. For nervous system effects, findings from human and rodent studies indicated Pb-induced impairments in learning but this coherence was not sufficient to address uncertainties in the ecological literature. The ISA for Pb serves as an example of how studies from multiple disciplines can be used to integrate evidence for effects across species. The views expressed in this abstract are those of the authors and do not necessarily represent the views or policies of the US EPA.
Laszcz-Davis, MS, CIH, AIHA Fellow, AIC Fellow optimizes the use of various OEL setting processes today. Chris and the surfacing of a “Hierarchy of OELs” concept which limitations, today’s world community challenges and drivers, setting processes today, a clarification of their strengths and highlight the historical evolution of OELs globally, known OEL government statute or have a guideline. The presenter will chemicals in worldwide use are presently either regulated by a now, particularly since only about 1,000-2,000 of over 100,000 the time to pause and re-examine the OEL setting processes is towards occupational hazard banding and the formulation of control assumptions without the apparent use of exposure data, time, the move towards a more global perspective on solving health issues, shifting centers of manufacturing growth, tendencies towards occupational hazard banding and the formulation of control assumptions without the apparent use of exposure data, the time to pause and re-examine the OEL setting processes is now, particularly since only about 1,000-2,000 of over 100,000 chemicals in worldwide use are presently either regulated by a government statute or have a guideline. The presenter will highlight the historical evolution of OELs globally, known OEL setting processes today, a clarification of their strengths and limitations, today’s world community challenges and drivers, and the surfacing of a “Hierarchy of OELs” concept which optimizes the use of various OEL setting processes today. Chris Laszcz-Davis MS, CIH, AIHA Fellow, AIC Fellow

Laszcz-Davis, C; Maier, A*; The Environmental Quality Organization, LLC; maierma@ucmail.uc.edu

Hierarchy of OELs--A New Organizing Principle for Risk Assessment

Risk assessment and risk management professionals have considered Occupational Exposure Limits (OELs) to be one of the most effective tools for performing risk assessments upon which risk management strategies for worker protection can be based. Occupational Exposure Limits (OELs) have been established for airborne workplace chemicals by various regulatory and authoritative organizations for well over 60 years now. With the changing regulatory arenas globally, a move towards a more global perspective on solving health issues, shifting centers of manufacturing growth, tendencies towards occupational hazard banding and the formulation of control assumptions without the apparent use of exposure data, the time to pause and re-examine the OEL setting processes is now, particularly since only about 1,000-2,000 of over 100,000 chemicals in worldwide use are presently either regulated by a government statute or have a guideline. The presenter will highlight the historical evolution of OELs globally, known OEL setting processes today, a clarification of their strengths and limitations, today’s world community challenges and drivers, and the surfacing of a “Hierarchy of OELs” concept which optimizes the use of various OEL setting processes today. Chris Laszcz-Davis MS, CIH, AIHA Fellow, AIC Fellow

Lazo, JK*; Bostrom, A; Morss, RE; Demuth, JL; Lazrus, H; National Center for Atmospheric Research; lazro@ucar.edu

Value of Improved Hurricane Warnings: Risk Information and Factors Affecting Stated Preferences

Hurricanes Katrina in 2005 and Sandy in 2012 exemplify the significant and recurring risk posed by hurricanes. How people receive, understand, and respond to hurricane information can lead to harmful behaviors such as failing to evacuate. People’s perceptions of hurricane risk are multi-dimensional and influenced by a variety of factors, from prior experience to vulnerability to risk preferences. As part of our research examining how extreme weather warnings are communicated, obtained, interpreted, and used in decision making by diverse participants in the warning and decision process we conducted a survey of hurricane vulnerable households in Florida and Texas. We report here on analysis of data collected in an online survey using Knowledge Networks KnowledgePanel in May 2012. 808 respondents completed the survey (460 in Miami-Dade and 348 in Galveston-Houston), for a 61.6% response rate. Initial results show that respondents’ stated likelihood of evacuation is contingent on information received, as well as demographic and contextual differences, with evacuation more likely on receipt of an evacuation order than after seeing a threatening forecast, higher for women than men, and higher in Houston-Galveston than in Miami, for example. Controlling for other factors, stated evacuation intentions depend on trust in the information received, motives for evacuation, and perceived barriers to evacuation, but do not appear to differ by cultural ideology. We report also on a dichotomous choice experiment for programs to improve hurricane warning information across different attributes of that information including landfall location, wind speed, inland flooding risks, and storm surge information, and controlling for information recipient characteristics and perceptions. Findings identify possible improvements to hurricane risk communication to reduce ineffective protective responses, and for research to identify and resolve gaps in the risk communication process.

Lazarus, H; National Center for Atmospheric Research; hila@ucar.edu

The roles of culture and science in climate change related migration decisions

Communities on low-lying islands and other low-lying areas face multiple, intersecting risks from climate change, land use change and other demographic and social change. In the face of so much transition, cultural integrity is an increasingly important force that is helping individuals and communities navigate responses to these risks including in-situ adaptation efforts as well as migration considerations. Risk frameworks that describe migration must therefore include cultural responses and priorities to climate change impacts. In this way, local agency can be considered alongside climate projections in adaptation decisions. As climate change challenges our contemporary configuration of place-based city, state and national government, we must think carefully about power and what is empowering: What is the effect of climate change knowledge and discourse on local communities’ culture and agency? How can climate victims become early responders? What are the roles of climate scientists, adaptation agencies, and community members in decision making?
Socio-economic analysis is a well-established method of weighing up the pros and cons of an action for chemical replacement as a whole and plays a vital role in the restrictions and authorization processes. One of the important analyses is the estimation of value of a statistical life (VSL) in SEA. The VSL that examine the economic value of benefits of avoiding selected adverse human health outcomes due to exposure to chemicals is estimated through willingness to pay (WTP). A few countries has been conducting online questionnaire to provide WTP. In this study, we developed the online program that can estimate the benefit and conducted a questionnaire survey. The area of residence, age, health status, disease diagnosis, and induction willingness to pay are included in the online program. We developed an integrated system to calculate the B/C ratio through estimation of benefit and cost using the data of the value of a statistical life (VSL), cost of illness (COI), and results of cost valuation, in this study. This system is made by Microsoft excel and concluded input sheet (essential data of VSL that examine the economic value of benefits of avoiding selected adverse human health outcomes due to exposure to chemicals is estimated through willingness to pay (WTP). A few countries has been conducting online questionnaire to provide WTP. In this study, we developed the online program that can estimate the benefit and conducted a questionnaire survey. The area of residence, age, health status, disease diagnosis, and induction willingness to pay are included in the online program. We developed an integrated system to calculate the B/C ratio through estimation of benefit and cost using the data of the value of a statistical life (VSL), cost of illness (COI), and results of cost valuation, in this study. This system is made by Microsoft excel and concluded input sheet (essential data of plant manufacturing chemical substance related adverse human health, risk population of cancer and illness, target illness and VSL, cost to replace chemical substance in plant, results of benefits and costs). In this study, we will develop the system servicing by online and send to chemical plant to review and confirmed the use feasibility.

**P.43** Lee, YJ*; Lee, GW; Yang, JY; Lee, HS; Shin, DC; Yonsei University College of Medicine; guerrilla75@hanmail.net

**SEA(socio-economic analysis) system for replacement of hazard chemical substances in Korea**

Disposal of radioactive waste is an important issue facing current and future generations. Radioactive waste is viewed by most jurisdictions and the public as being fundamentally different from other hazardous wastes such as toxic metals and organic chemicals, despite the fact that the ultimate health outcomes resulting from exposure may be similar. Current strategies involve long-term isolation of waste as long as the waste poses an unacceptable risk to society. Decisions under uncertainty address the location and hydrogeology of the site, the means of disposal (near surface, deep geological), the engineering design, and the required lifetime of the disposal facility. Currently, regulatory agencies specify inconsistent periods of time (i.e., compliance periods) over which risks must be estimated in order to determine appropriate disposal requirements. These periods range from decades to millennia, depending upon the regulator and type of waste involved (low-level, transuranic, or high-level). We summarize current approaches for evaluation of future radioactive waste risks and application of compliance periods. We then explore the compliance period issue from a variety of different perspectives including: the inability of humans to accurately forecast the future; long-term psychological, social, evolutionary, and technological changes; long-term physical changes in the Earth’s systems; economic approaches to valuation of future risks and benefits of policies; and, financial planning. All of these perspectives are subject to great deal of uncertainty, which typically increases over time. We conclude with pragmatic recommendations regarding marked yet needed modification of current regulatory approaches. These include compliance periods measured in decades rather than millennia, with frequent re-evaluation and establishment of maintenance and financial mechanisms to ensure that unacceptable releases do not occur.

**M4-J4** Lee, J.; East Carolina University; leejoo@ecu.edu

**The Antecedents of Enhancing Behavior Following Mandatory Motorcycle Helmet Legislation**

This study uses a national survey of 300 U.S. motorcycle riders to identify the relevant factors contributing to reduced risk taking among motorcyclists in mandatory helmet law states. Importantly, the survey asks participants about their annual motorcycle vehicle miles traveled, motorcycle tourism, perceptions of helmet efficacy in preventing death and injury, alcohol use, and membership to motorcycle rights groups. Results indicate that motorcyclists in mandatory helmet law states take more motorcycle tourists trips to other states, and are more inclined to believe that helmets increase the risk of serious neck injury for those involved in crashes. Consequently, behavioral adaptations among motorcyclists’ in mandatory helmet law states in the form increased tourist travel behavior and compensation for perceived increased neck injury risks appear to be the main source of enhancing behavior with respect to motorcycle helmet laws.

**P.26** LeHuray, AP*; Sunn, T-J; Beatty, P; Reitman, F; Naphthalene Council; alehuray@naphthalene.org

**Naphthalene Research Program: Working Hypotheses and Research Results**

Early in the 21st century, naphthalene was classified as a possible human carcinogen (2B) by the International Agency for Research on Cancer (IARC) and as reasonably anticipated to be a human carcinogen by the National Toxicology Program (NTP) in the United States (US). Both classifications were based on tumors observed in laboratory rats exposed to elevated doses of naphthalene for two years. There is little evidence to suggest exposure to naphthalene is associated with cancer in humans. With support from the US Environmental Protection Agency (EPA) and industry groups, a three-day workshop - the Naphthalene State-of-the-Science Symposium (NS3) - was convened to evaluate scientific knowledge about naphthalene carcinogenicity and the relevance of cancer findings in experimental rodents to assessing cancer risks of human exposure to naphthalene. NS3 deliberations, conclusions and recommendations resulted in seven papers published in a special issue of Regulatory Toxicology & Pharmacology in 2008. Industries interested in the question of whether naphthalene should be classified as a possible or reasonably anticipated human carcinogen formed the Naphthalene Research Committee (NRC) as a vehicle to identify and fund scientific studies that, guided by NS3 deliberations, could help answer questions about naphthalene carcinogenicity. To support naphthalene research, NRC participants pledged $5 million over the 5 years 2007 - 2011. At the SRA 2014 conference, key findings from the NRC research program and their implications for human risk assessment will be presented.
Projecting climate damages
We develop a top-down approach to estimating market damages from climate change. This new approach combines damages from altering average temperature and precipitation and damages from changing the variance of temperature and precipitation. We obtain the regional distribution of each type of damages as a function of global mean surface temperature. The results demonstrate the importance of assumptions about regional income growth and the importance of the weighting scheme used to aggregate regional impacts into a global damage function.

M2-H.3 Lewandowski, T*; Peterson, M; Gradient, Suite 803, 600 Stewart Street, Seattle WA 98101; 
tlewandowski@gradientcorp.com
PBPK evaluation of the combined effect of goitrogens and iodine from food
The European Commission has established provisional reference values pertaining to perchlorate in food items including fruits and vegetables. The reference levels were promulgated to encourage member states to collect data on the concentrations of perchlorate in food in advance of a scientific opinion concerning perchlorate risks in food. Data on the perchlorate content of food by itself are not sufficient for developing informed risk management decisions, however. Because the impacts of perchlorate and similar ions are modulated by iodine status (and intake), evaluating the possible impact of perchlorate on thyroidal function must include consideration of underlying iodide status, as well as the intake of iodide in foods that may also contain perchlorate. Using data on the concentrations of perchlorate in fruits and vegetables, we modeled the impact of consumption on free thyroxine (fT4) levels in pregnant females and their fetuses, along with the levels of iodide intake that would be necessary to counteract those effects, using the physiologically based pharmacokinetic model of Lumen et al. (2013). We found that the levels of additional iodide needed can easily be obtained from a normal serving size of various foods including dairy products, fish, or enriched breads, or by consuming produce grown with iodine-containing fertilizers, which are known to increase the iodide content of vegetables in cases where they are applied.

M2-B.4 Lemoine, D; University of Arizona; 
dlemoine@email.arizona.edu
Projecting climate damages
The results demonstrate the importance of assumptions about regional income growth and the importance of the weighting scheme used to aggregate regional impacts into a global damage function.

T4-I.2 Lentz, TJ; CDC/National Institute for Occupational Safety and Health/Education and Information Division; tbl7@cdc.gov
Considerations for Aggregate Exposure Assessment and Cumulative Risk in Setting Workplace Exposure Limits
The traditional approaches to assessing work-related exposures and managing hazards have focused on assessments of exposures to individual chemical hazards or groups of similar compounds from exposures via the inhalation route. While these approaches facilitate the assessment process, they do not necessarily reflect the complexity of the work environment involving exposures to multiple compounds and stressors, and the possibility that cumulative exposures may modify the effects and their severity through interactive processes. This realization serves to underscore the importance of considering multiple stressors, exposure routes/pathways, and contributions of non-occupational exposures in assessing risks of adverse health effects. Factors leading to broader examination and approaches for assessing risk will be discussed, including advances in exposure assessment and control of gross airborne exposures to chemicals, as well as improved knowledge of toxicology and methods for evaluating other exposure routes. Of special relevance to cumulative risk assessment are the considerations for Total Worker Health™; these will be acknowledged through examples of emerging scientific tools and practices for cumulative risk assessment, along with suggested resources for occupational health professionals to help evaluate risks from exposures in the work environment and in non-occupational settings. These examples will be described in the context of a broader effort to produce NIOSH guidance and methods for improving the practices for setting occupational exposure limits.

W4-E.2 Lewis, RJ*; Grant, R; Santos, S; Dourson, M; Shirley, S; Erraguntla, N; ExxonMobil Biomedical Sciences, Inc; Texas Commission on Environmental Quality; Focus Group and Excellence for Risk Assessment; Texas Commission on Environmental Quality; and Texas Commission on Environmental Quality; r.jeffrey.lewis@exxonmobil.com
Unpacking Toxicity Assessments to Understand and Improve Confidence
To improve our understanding of hazard assessments, we have devised an approach, including a graphic illustration, that will enhance the discussions on the confidence in toxicity values (cancer and non-cancer) by identifying and discussing major elements of a toxicity assessment. While current approaches focus on understanding database completeness and study quality, our systematic approach will help characterize the level of confidence and accuracy of cancer and non-cancer hazard values based upon an evaluation of a set of eight major elements used in a toxicity assessment. For a risk assessor, the inclusion of these 8 elements in an IRIS assessment summary will improve their understanding of confidence in the toxicity value, and will assist them in risk communication to risk managers/decision makers. This presentation will discuss these elements, and describe how they can be scored and graphically depicted with specific examples to help users understand the confidence they should have in a particular hazard assessment.
W1-H.4 Lewis, RJ*; Beck, N; ExxonMobil Biomedical Sciences, Inc. and American Chemistry Council; r.jeffrey.lewis@exxonmobil.com

EPA’s Framework for Human Health Risk Assessment to Inform Decision Making: An Industry Perspective

The U.S. Environmental Protection Agency’s (EPA) new framework guidance on conducting human health risk assessments provides a positive contribution towards addressing many industry and National Academy of Sciences recommendations regarding improving scientific quality and timeliness of Agency assessments. The framework provides high level guidance on aspects such as planning, scoping, and problem formulation, which are important to developing “fit for purpose” assessments with improved utility. Other constructive aspects include the emphasis on relevant high quality data; transparency regarding assumptions, limitations, and rationale for decisions; emphasis on expected or central estimates of risk and providing a range of risk estimates; importance of public and stakeholder input, especially at the planning stage; and peer review. Additional clarification by the Agency on scope and timing of implementing these guidelines across the Agency would be beneficial, especially with regards to the EPA’s Integrated Risk Information System (IRIS) program. Finally, other important NAS recommendations about specific methodologies (e.g., articulation of a systematic approach for weighing evidence, characterizing confidence and uncertainty in toxicity values) remain to be addresses by the Agency.

W2-I.1 Lewis, AS; Beyer, LA; Zu, K*; Gradient; kzu@gradientcorp.com

Quantitative Cancer Criteria for Inorganic Arsenic Exposure via Inhalation: A Non-Linear Approach

The inhalation unit risk (IUR) for inorganic arsenic was developed by the United States Environmental Protection Agency (US EPA) in 1984 based on respiratory cancer mortality data from two US occupational cohorts. Since 1984, three new analyses generated IURs that are lower (i.e., less restrictive) than the current US EPA value of 4.3 x 10^-3 (µg/m3)-1. All four developed IURs are based on cumulative exposure to arsenic and low-dose linear extrapolation. While the mode of action (MOA) for inorganic arsenic via inhalation is not precisely defined, the MOA of inorganic arsenic via ingestion and mechanistic data collectively support a possible threshold for inhaled arsenic with regard to carcinogenesis in the lung. Findings from occupational studies also suggest that average concentration of arsenic in air is more relevant as the exposure metric than cumulative exposure to arsenic. In light of this information, and consistent with the US EPA Cancer Guidelines, we used a non-linear (threshold) approach to characterize risks to the general population from arsenic exposure via inhalation. Applying an empirical nonlinear model to the occupational data, we established points of departure based on both cumulative exposure (µg/m3-years) to arsenic via inhalation and average arsenic concentration in air (µg/m3). We then assessed the lifetime risk of respiratory cancer mortality associated with ambient concentrations of arsenic in air in the general population of the US using a margin of exposure (MOE) approach. The MOE based on average concentration (MOE = 3452) was much larger than the MOE using cumulative exposure (MOE = 43), suggesting that arsenic cancer risk assessment via inhalation is sensitive to the exposure metric used. Using a non-linear approach, we concluded that there was no unacceptable risk of respiratory cancer associated with a lifetime exposure to background levels of arsenic in ambient air.

W2-D.1 Li, SY*; Zhuang, J, Shen, SF; Tsinghua University; 474042502@qq.com

Defensive Resource Allocations for an Assembly Occupancy System in a Sequential Defender-attacker Game

Attacker-defender games have been studied in the past decades, where optimal defensive resource allocation was studied in this paper with intentional attacks, using game theory and risk analysis methods. Based on this literature, this research considers a series of assembly occupancies, such as large railway stations, as the system targets. The model focuses on direct-contact attack; e.g., using swords or knives from short distances. We use scenario simulation to calculate the human value of target, considering the situations of the target and resource allocations for both the attackers and defenders. In our attack scenario, there are three types of players: normal individuals, attackers and police. Attackers try to cause the largest casualties. The normal individuals’ reactions are divided into three categories after they feel abnormal: going towards the shaking (e.g., going to the ticket hall). Symbolic values are assessed through the significance of assembly occupancy. Then, the optimal resource allocations among the target system for both the attackers and defenders are studied in a n-period game. In our case study, we consider 49 Chinese Railway Special Stations under potential risks of direct contact attack. We use the 2014 terrorism attacks to Chinese railway stations to validate and illustrate the model. This paper provides some novel insights to the homeland security resource allocation.
A Quantitative Weight of Evidence Model for Assessing Adverse Outcome Pathways (AOPs)

Weight of evidence (WOE) evaluation has been recommended for Adverse Outcome Pathways (AOPs) assessment, but the majority of weight of evidence (WOE) frameworks have been qualitative in nature and may not satisfy the growing needs for objectivity and transparency that are necessary for regulatory decision making. This presentation discusses a quantitative WOE framework that utilizes multi-criteria decision analysis (MCDA) methodology for integrating evidence underpinning key events and key event relationships within an AOP. Building from the tailored Bradford Hill (BH) considerations and defining questions developed in a March 2014 workshop, a prototype model was developed, and for illustration purposes, the was parameterized by input from a few mode of action studies and judgments of individual experts. Application of the framework is illustrated for a hypothetical, but realistic case study, but the approach is designed to support evaluation of a wide range of AOPs. To refine this parameterization, a consensus expert elicitation approach seems feasible in the near future, once enough experience has been gained by experts in applying tailored BH considerations to AOPs. (This abstract does not reflect policy of any of the authors' organizations.)

Probability Analysis of Multiple-Tank-Car Release Incidents in Railway Hazardous Materials Transportation

Railroads play a key role in the transportation of hazardous materials in North America. Rail transport differs from highway transport in several aspects, an important one being that rail transport involves trains in which many railcars carrying hazardous materials travel together. By contrast to truck accidents, it is possible that a train accident may involve multiple hazardous materials cars derailing and releasing contents with consequently greater potential impact on human health, property and the environment. In this paper, a probabilistic model is developed to estimate the probability distribution of the number of tank cars releasing contents in a train derailment. Principal operational characteristics considered include train length, derailment speed, accident cause, position of the first car derailed, number and placement of tank cars in a train and tank car safety design. The effect of train speed, tank car safety design and tank car positions in a train were evaluated regarding the number of cars that release their contents in a derailment. This research provides insights regarding the circumstances affecting multiple-tank-car release incidents and potential strategies to reduce their occurrences. The model can be incorporated into a larger risk management framework to enable better local, regional and national safety management of hazardous materials transportation by rail.

Data derived extrapolation factors: Improving the quantitative basis for human health risk assessment

Quantitative risk assessment requires a framework and standards for data evaluation. The U.S. EPA’s Risk Assessment Forum has published Data Derived Extrapolation Factors (DDEF) guidance (2014). This guidance is consistent with policy established in the 2005 Cancer Guidelines and with the recommendations of the National Academies of Science. The guidance instructs how to identify and evaluate toxicokinetic (TK) and toxicodynamic (TD) data to develop quantitative DDEF values for inter- and intraspecies extrapolation, avoiding default uncertainty factors for these extrapolations. Adverse health outcomes result from interactions between the toxicologically-active chemical species and the biological receptor, expressed at the cellular or molecular level. As such, target tissue concentrations demarcate TK and TD contributions to the response. Target tissues, toxicologically active chemical species and necessary biological elements can be identified by understanding major components of the mode of action. TK quantitation is based on relationships between dose and target tissue concentrations in test species and in humans. TD quantitation is based on relationships between target tissue concentrations or in vitro concentrations producing the same level of the biological response in test species and humans. In vitro or in vivo responses used for TD quantitation must be tied to the adverse health outcome. Evaluations of human variability require a sample set representing the diversity of the human population; application of DDEF principles can elucidate the TK or TD basis for sensitivity. This DDEF guidance addresses TK model characterization, use of high throughput in vitro data, and mode of action evaluation; it guides the evaluation of multiple possible points of departure. It represents initial guidance for quantifying TD differences between and among species and for quantifying human interindividual variability. These principles are demonstrated in multiple case studies.
Transparency and Trust in the European Pharmaceutical Sector: Outcomes from an Experimental Study

In an era of increased pressure to enhance regulatory and governmental transparency, how are the public likely to react to more raw safety-related information being released into the public domain? Many pharmaceutical regulators have committed to a more open, inclusive, and transparent model of decision-making in recent years. Yet, based on little empirical evidence, they have overwhelmingly adopted ‘fishbowl’ transparency policies, ‘the full disclosure of information without explanatory information or contextualization’ (e.g. heightening access to raw data). The presenter conveys recent findings from an open-ended questionnaire with 200 face-to-face interviews carried out in the UK and the Netherlands. The recently published study provides evidence on how members of the public are likely to react to ‘fishbowl’ transparency policies and receiving decontextualized data. After showing respondents raw data from a periodic safety update report (a safety-related document that pharmaceutical regulators are proposing to proactively release), the survey found they were shocked, concerned, and more worried, while many said they would reconsider taking their medicines and seek further advice. Based on these findings, the presenter argues that researchers and decision-makers need to develop a more sophisticated understanding of ‘transparency’, which should be integrated with effective, evidence- and science-based benefit/risk communication.

A Consumer’s Guide to Chemical Risk

Modern communication methods, particularly internet-based sources, offer consumers access to more information and data than ever before. This positive trend is offset, however, by the Internet’s power to disseminate misleading information. In particular, consumers are increasingly exposed to a wide-range of warnings and claims about alleged averse health impacts of consumer products based largely on hazard rather than risk. Unfortunately, many researchers exacerbate this problem by using loaded rhetoric in research studies, which activist groups exaggerate further and repeatedly market through blogs, social media, and viral email. The result is widespread and unbalanced public perceptions about the risks associated with consumer products, coupled with little consideration of benefits. Public officials respond by advancing unproductive regulations and retailers in turn demand “safer” products from suppliers. Rather than launch a defense, larger manufacturers are increasingly reformulating products voluntarily in an attempt to restore consumer confidence while smaller manufacturers often just discontinue products, reduce innovation and sometimes just go out of business. As valuable products disappear from the market, expensive efforts to reformulate are increasingly met with yet more demands for reformulation. This presentation will explore how risk communicators can counter-balance the flow of misleading information online by developing their own internet-based sources of risk-based messaging that appeal to consumers who are looking for answers and alternative viewpoints.

Risk Assessments Algorithms and the legitimacy of public policy

Meta-political concept of risk implies that politics, conceived as the science of collective action, deal with a future which is lived as a threat. The logical reasoning governing this kind of politics is probabilistic calculus, and its goal is the identification and prevention of risks that are defined as such risks. Therefore, in risk societies the favorite political tools are the methods for their assessment, through which risks are identified or defined. Algorithms employed in risk assessment procedures or tools became the fountainhead of legitimacy for the risk management public policies. This paper analyses if these algorithms, usually built upon the idea of static time, are suitable for dealing with an ever-changing reality, through the study of gender violence risk assessment tools. Conclusions show that management risk public policies would lack sustenance if risk assessment algorithms are built upon a concept of static time; insofar this concept is in clear contradiction with the purpose algorithms aim at.

Cumulative risk assessment for pesticides: Lessons learned on scoping and problem formulation

EPA’s Office of Pesticide Programs (OPP) is required by the Food Quality Protection Act (FQPA) to take into account “available evidence concerning the cumulative effects on infants and children of such residues and other substances that have a common mechanism of toxicity.” The Office of Pesticide Programs (OPP) previously developed two guidance documents related to identifying common mechanism groups and conducting cumulative risk assessment of pesticide chemicals. To date, OPP has established five common mechanism groups (CMGs): organophosphates (OPs), N-methyl carbamates (NMCs), chloracetanilides, triazines, and pyrethroids. Cumulative risk assessments have been conducted on each group (http://www.epa.gov/oppsrrd1/cumulative/). Neither existing guidance document provides a detailed discussion of how to screen and/or prioritize additional groups of pesticides for cumulative evaluation. OPP is currently developing guidance on screening and prioritizing these chemicals, focusing on risk assessment principles related to the integration of toxicology and exposure such as chemical structural similarity, hazard profile, mode of action/ adverse outcome pathway, pesticide exposure pathways and pesticide use profiles. This presentation will describe the status of this effort and provide key examples.
The recent appearance of the starfish wasting disease among thousands of starfish along the U.S. west coast has attracted substantial attention. Unfortunately, the exact cause of this disease, which is triggering high mortality of starfish, has not been found yet. News coverage of the disease typically focuses on the tragic scenes of starfish dying and/or the high-uncertainty surrounding the cause of the disease, which is likely to elicit emotional responses, such as sadness and anxiety. Loss-framed consequences are also heavily used in the coverage. However, how these components presented in the news may have an impact on the public is unknown and needs further investigation. Since many environmental risks appear impersonal, this study attempts to bridge the perceived distance between humans and the environment by delving into the emotion-as-frame perspective, and developing affective bonds between them. Online experiments are currently being conducted to investigate the impacts of message-relevant discrete emotions (anxiety vs. sadness) in the communication of this novel environmental risk. This study is particularly interested in discovering the interaction effects between message-relevant emotions and gain versus loss framing on risk perception, information seeking, and policy support for protecting marine species. Since the action tendency for sadness is to seek reward and for anxiety is to avoid threat, one major prediction is that a sadness- and gain-framed message will generate more policy support than a sadness- and loss-framed message, while an anxiety- and loss-framed message will generate more policy support than a sadness- and gain-framed message. Implications for how to incorporate emotional appeals with cognitive framing in risk communication are discussed.

Acrolein (CH₂=CH-CHO) is an air toxic found frequently in the environment. The U.S. Environmental Protection Agency (EPA) considers acrolein to be a noncancer risk driver (EPA, 2011). To describe noncancer effects, the EPA currently uses threshold-based values such as the Reference Dose or Concentration (RfD/RfC). Below these levels, there is presumption of no appreciable risk; above the RfD or RfC, there is potential for harm, although this risk is not estimated. For inclusion in benefits estimation, it is more useful if the risk due to exposure can be quantified. The Straw Man Model, described by Hattis et al. (2002), is one example of a probabilistic risk assessment tool that could be used to estimate noncancer risks. The model assigns specific distributions based on empirical data in place of traditional uncertainty factors, using a preassembled database of toxicological information. The model outputs for air contaminants are (1) a distribution of concentrations corresponding to a specified risk level, and (2) uncertainty distributions of expected risks of a particular health effect as a function of chronic air concentrations. We will describe our modifications to the approach described by Hattis et al., 2002, and our choice of input parameters, including an updated Regional Gas Dose Ratio (RGDR) distribution. Rather than using the original risk criteria of 1/100,000, we use a risk level of 1/1000 due to nature of the endpoint modeled (mild nasal hyperplasia). Our case study demonstrates that a probabilistic model such as the Straw Man can be used to estimate the risk of air toxics such as acrolein. Risk estimates will be presented in the context of recent ambient levels. However, the results of this analysis should be considered illustrative.
P.182 MacDonald Gibson, J*; Johnston, J; DeFelice, N; University of North Carolina at Chapel Hill; jackie.macdonald@unc.edu

Water and Sewer Service Disparities in North Carolina: Public Health Risks
The development of community water supply service was one of the greatest public health advances of the twentieth century, credited with a 50% reduction in premature mortality between 1900 and 1936. However, evidence suggests that selected minority communities across the American South have been systematically denied access to community water supplies. The extent of such water service disparities and their public health implications have not been previously analyzed in North Carolina. This poster presents the results of a geographic analysis of water service disparities in Wake County, North Carolina, location of the state capital, and of a study of the relationship between access to community water service and risk of emergency department visits for acute gastrointestinal illness (AGI). The results show statistical evidence of systematic disparities in water service levels in extraterritorial jurisdictions of Wake County. In addition, lack of access to community water service significantly increases the risks of emergency department visits for AGI.

M2-C.2 MacGillivray, BH; Cardiff University; macgillivraybh@cardiff.ac.uk

Causal modelling in regulatory contexts - the problem of structure altering interventions
In modelling environmental and public health problems, the causal principles that we work with are generally derivative rather than fundamental. And so they vary quite widely in terms of depth, generality, and scope. A major issue that stems from this is that our causal models may be unstable under interventions (c.f. the Lucas Critique). That is, we may use a causal model to predict the results of a policy intervention, but the act of intervening may actually disrupt the causal principles upon which we rely. Put another way, “what if a policy intervention changes the very model that purports to predict its effect?” (Judea Pearl) This rather esoteric sounding problem has been at the heart of policy implementation problems across a range of areas, from tackling food production problems in developing countries, to behavioral interventions in the climate change context. This problem of “structure altering interventions” is often discussed, but inadequately characterized, and as a result is difficult to account for formally in policy analysis. Here, we seek to clarify the notion of structure altering interventions, develop a typology of them, and use examples from various environmental and public health domains to cash out the ideas. Structure altering interventions are related to but distinct from the problem of external validity. Whilst external validity is concerned with whether causal models can be transported from one domain to another, here, we need to focus on the intersection between model specification and query specification.

M4-H.3 MacDonell, M*; Hertzberg, R; Chang, YS; Rice, G; Yurk, J; Martin, L; Argonne National Laboratory (authors 1, 2, 3); U.S. EPA (authors 4, 5, 6); macdonell@anl.gov

Cumulative Risk Assessment for Combined Air Toxics and Criteria Pollutants
Air pollution represents a key area for cumulative risk assessment approaches that support practical decisions for environmental health protection. With childhood asthma and adult respiratory issues on the rise, interest is growing in ways to combine risk estimates for different types of pollutants. The risk metrics and underlying data for the criteria pollutants – carbon monoxide, lead, nitrogen oxides, ozone, particulate matter, and sulfur dioxide – differ from those for air toxics (such as benzene and mercury). The health-based National Ambient Air Quality Standards (NAAQS) established for the six criteria pollutants reflect population incidence data from extensive epidemiological studies. In contrast, toxicity reference values are used to estimate risks for hazardous air pollutants (HAPs), and most of these values are derived from animal studies. For example, dose-response models are applied to animal data, followed by quantitative extrapolation across species and exposure durations to calculate a reference value considered generally safe for human exposures. For some chemicals, the reference value is scaled from a measured animal exposure concentration, while for others the exposure concentration is modeled to correspond to an acceptably low risk level. A cumulative risk assessment that addresses combined criteria pollutants and HAPs must combine different types of risk-based concentration estimates. This presentation includes approaches for characterizing risks for pollutant mixtures and qualitatively assessing the uncertainty of those estimates; it also considers the consequences of increased uncertainty when the combined exposure includes nonchemical stressors and personal characteristics.

M4-G.5 MacKay, C*; Cubberley, R; Dhadra, S; Gelliaty, N; Pendlington, R; Pickles, J; Saib, O; Sheffield, D; Stark, R; Maxwell, G; Unilever - Safety and Environmental Assurance Centre; cameron.mackay@unilever.com

Applying mechanistic modelling to human health risk assessment: a skin sensitisation case study
Recently proposed approaches for human health and ecotoxicological risk assessment of chemicals, such as Toxicity Testing in the 21st Century and adverse outcome pathways (AOPs), put strong emphasis on having a deeper understanding of the mechanism of action. Our aim is to directly apply our mechanistic understanding of the skin sensitisation response in assessing the likelihood of sensitisation occurring in humans following a defined chemical exposure (dose per unit area of skin exposed). Central to our approach is mathematical modelling of the underlying biology and evaluation of model output against available clinical data on sensitisation. We present our current mathematical model of the skin sensitisation response. The model outputs naïve CD8+ T cell activation as a surrogate measure for sensitisation induction in humans. Ordinary differential equations are used to model key events of the AOP: skin penetration (chemical diffusion and partitioning), haptenation of protein nucleophiles and antigen processing and presentation by skin dendritic cells. Biological parameters are taken from immunological literature with human data used where possible. Chemical-specific parameters are derived from bespoke in vitro experiments and from sensitiser-specific literature. The model has been used to simulate a study (published previously by Friedmann et al. 1983) in which 132 healthy volunteers were exposed to one of five doses of the contact allergen 2,4-dinitrochlorobenzene. Comparison is made between this clinical data and simulation results. We also present a sensitivity analysis that explores the effect of varying chemical and biological parameters on characteristics of the simulated dose response. We explore the impact of varying exposure properties (e.g. dose, exposure duration) and compare our conclusions with those drawn from clinical observation. Finally, we propose how such an approach could be used in risk assessment.
Allocating resources to enhance resilience

We construct a model to help a decision maker allocate resources to increase his or her organization’s resilience where resilience is measured as a function of initial loss, the time to recovery, and the shape of recovery. Given a resilience function, a decision maker determines where to allocate resources from a fixed budget prior to a disruption in order to enhance resilience. Resources can be allocated to reduce the initial impact of the disruption, reduce recovery time, and change the shape of the recovery. We determine the optimal allocation of resources for a variety of functions that describe how resources reduce the initial loss, reduce the recovery time, and improve the recovery trajectory. Because resources are being allocated before the disruption, the initial loss, recovery time, and recovery trajectory may not be known with certainty.
**T4-I.4 Maier, A*; University of Cincinnati/Department of Environmental Health ; maierra@ucmail.edu**

**Paving the way: Research to practice in cumulative risk analysis for occupational health professionals**

The goal of addressing cumulative risk assessment is yielding a growing list of risk methods and modeling tools that are fit for specific applications. Related fields in the risk analyses community are developing powerful risk modeling tools, but many of the tools are not readily transferrable to or inclusive of all aspects of chemical health risk assessment. For example, some models focus on community level effects or risk of new product uses to consumers, but may not consider unique aspects of occupational scenarios. This presentation focuses on research needs that will support the transfer of technology among diverse aspects of the risk analysis community, with a specific aim of highlighting research opportunities to adapt models for occupational risks. Additional research needs address the need to provide tools that can be implemented by occupational health professionals in the field risk assessment setting.

**P.151 Mandel, A*; Stern, E; Tel Aviv University and Center for Risk Analysis, Kiryat Ono 5556022, Israel ; alonzo@umich.edu**

**Risk assessment of a chemical dispersed by an explosion**

Primary and secondary health effects from a ground explosion of a hypothetical chemical nicknamed “Zilithion”, are explored. The detonation/deflagration, which may occur as a result of either deliberate, hostile act or of an operational accident in a chemical facility (e.g. explosion of a Toluene tank), creates a “contaminated explosion column” as well as devastation around the point of explosion. People surviving the blast effects get either injured or incapacitated and presumably cannot escape. They are directly exposed to droplets dispersed due to the blast within the devastation radius and to non-buoyant droplets falling down gravitationally. The “heavy” droplets were assumed to have a uniform diameter, being ‘shot’ to various heights within the explosion column from which they started travelling to the environment, their dispersion being determined by vertical gravitational forces and horizontal wind velocities. These non-buoyant droplets settle down on people within and outside the explosion circle. Another chemical fraction, which is neutrally buoyant, disperses in the downwind direction as a Gaussian plume, which affects people mostly by inhalation and ground concentrations created through dry deposition processes. Under various assumptions, exposure to Zilithion droplets from gravitational settling resulted in a much higher whole-body skin concentrations compared to the direct exposure effects of the detonation energy. The aerosol concentrations calculated using a Gaussian plume model for day and night conditions, were input into a probit lethality function, using probit constants of the highly toxic gas, Phosgene. Under the assumptions made in this study, the concentration of Zilithion/Phosgene aerosols is not expected to exceed AEGL thresholds during ten minutes of exposure. Obviously, explosion accidents in chemical facilities have similar, though not identical, characteristics as hazardous materials dispersion caused by malevolent uses of explosives.

**P.144 Marano, KM*; Morgan, W; Ogden, MW; Swauger, JE; RAI Services Company; R.J. Reynolds Tobacco Company; maranok@rjrt.com**

**A Quantitative Risk Assessment of US Cigarette Products, 2012 and 2013**

Quantitative risk assessment, including incremental lifetime cancer risk (ILCR) and hazard index (HI) calculations, was applied to 160 cigarette products marketed in the United States (US) in 2012 and 2013. ILCR and HI values, incorporating both estimates of toxicity and concentration for individual harmful and potentially harmful tobacco constituents (HPHC), were calculated overall and for six cigarette subcategories including three ISO “tar” categories (i.e., <6 mg, 6-13 mg, >13 mg), each with a menthol and non-menthol subcategory. For determination of HPHC yields, cigarettes were machine-smoked using both the ISO regimen and the Health Canada Intense (HCI) regimen. For non-cancer and cancer toxicity estimates, values established by US regulatory authorities or values derived from more recent dose-response data were used. Overall, for cigarettes smoked using the ISO regimen, ILCR values ranged between 4.17E-4 (minimum) and 6.87E-3 (maximum), and HI values ranged between 238 and 3632. For cigarettes smoked using the HCI regimen, ILCR values ranged between 3.37E-3 and 1.33E-2, and HI values ranged between 4720 and 9065. These results provide a range of noncancer hazard and cancer risk estimates for current market cigarette products overall and by six subcategories. In the context of a toxicological risk assessment, it is suggested that a new cigarette product, with ILCR and HI estimates falling within the relevant subcategory ranges for current market products, does not raise different questions of public health.

**P.86 Makino, R*; Matsukura, K; Wada, Y; AIST; ryoji-makino@aist.go.jp**

**Development of an “easy-to-conduct” risk assessment method for occupational accidents in small and medium-sized enterprises**

The number of casualties in occupational accidents per year has been over 110,000 (including about 1,000 deaths) in Japan. In 2010, 50% of the casualties (56% of the deaths) were workers of small and medium-sized enterprises. This fact suggests that there is a need to focus on small and medium-sized enterprises in order to reduce the casualties of occupational accidents. In spite of the expectation that risk assessment and risk management is effective in reducing occupational accidents, many small and medium-sized enterprises have not conducted the risk assessment of occupational accidents. The purpose of this study is to examine the factors that inhibit small and medium-sized enterprises from introducing the risk assessments and to develop the risk assessment method that can be easily introduced to those enterprises. This poor diffusion of the risk assessment among small and medium-sized enterprises is due to the fact that they are often in a severe situation in terms of financing and human resources. Therefore, the risk assessment method for small and medium-sized enterprises must be the one that does not require many human resources, much money, or much time to conduct it. In addition to that, results of “easy-to-conduct” risk assessment method must have enough degree of precision to contribute the reduction of occupational accidents. In this presentation, we show the result of (i) questionnaire survey on the factors inhibiting the introduction of risk assessments and (ii) the trial risk assessments for occupational accidents in small and medium-sized enterprises using our newly developed method. Our easy-to-conduct risk assessment method has been developed on the basis of the Safety Competency Assessment System promoted by Ministry of Economy, Trade and Industry of Japan.
Nanotechnology: From Harmful to Helpful?

Marchant, G*; Hartley, K; Arizona State University; Gary.Marchant@asu.edu

With the rapid emergence of nanotechnology came benefits from a myriad of improved products ranging from cosmetics to airplane wings. However, nanoparticles, the source of these improvements, also generated fear that exposure to even low doses would be harmful. This paper will delve into the world of nanoparticles and risk. More specifically, it will address evidence regarding the nature of their dose-response, their potential health implications when exposure is limited to the low-dose zone, and the potential harms to both scientific knowledge and public health that could result from inadequate consideration of such evidence. Recent evidence suggests that, like many other high-dose hazards, nanoparticles exhibit a low-dose stimulatory/high-dose inhibitory pattern. This implies that if exposure is limited to low doses these nanoparticles may induce positive reactions through preconditioning and adaptive response, rather than automatic harm. What does that imply about public health and the risk management of nanoparticles? Can these nanoparticles in fact be used to develop potential health remedies, even preventive medicine? Or is the implication simply that evidence does not warrant fear of low-dose exposure? In either case, the potential of emerging technologies such as nanotechnology will be severely limited if the adopted lens of analysis ignores the protective effects that may be induced by low-dose exposure. This session will be co-presented with Kirk Hartley.

Genetic Biomarkers of Risk in Toxic Tort Litigation

Marchant, GE*; Hartley, K; Arizona State University and LSP Group LLC; gary.marchant@asu.edu

Genetic biomarkers of risk are increasingly being used in toxic tort litigation by both defendants and plaintiffs. Two major categories of biomarkers are being deployed – (i) genomic changes from toxic exposures that serve as biomarkers of exposure or risk; and (ii) genotypic variants that affect the carrier’s individual risks to toxic exposures. The use of such genetic biomarkers in toxic tort litigation has the potential to make the outcomes of such lawsuits more accurate, fair and just. At the same time, these biomarkers present difficult scientific, legal and ethical challenges. The evidentiary, doctrinal and normative implications of genetic biomarkers will be analyzed in this presentation using two different sets of lawsuits that have begun utilizing such biomarkers. First, over a dozen benzene cases have attempted to use breaks in specific chromosomes as evidence of causation in plaintiffs exposed to benzene who developed leukemia. Both plaintiffs and defendants have sought to use such biomarkers with mixed success to date. Second, mutation specific analysis is also entering asbestos litigation. Mutations to the BAP1 gene are now associated with “mesothelioma” families in the US and abroad. Other genetic biomarkers also are being put to use in asbestos litigation, including results from microRNA tests. After reviewing these two case studies on how genetic biomarkers are already being used in important toxic tort litigation, this presentation will project some future projections on how genetic biomarkers are likely to transform toxic tort litigation over the next decade.

Resilience of Critical Infrastructure

Massaro, E; Steen, A; Gutfraind, A; Collier, ZA; Kott, A; Linkov, I*; US Army Engineer Research and Development Center; Igor.Linkov@usace.army.mil

A Complex Network-based Approach for Quantifying Resilience of Critical Infrastructure

Our society is highly dependent upon an increasingly connected network of infrastructure, technological, and social systems. This complex, interdependent dynamical system is vulnerable to man-made and natural disruptions. In highly uncertain, complex, and unpredictable systems such as these, we must move away from traditional risk-based approaches and towards a resilience-based approach. Unfortunately, resilience is still a poorly understood concept that is often confused with risk. In this paper, resilience is defined as a network property of the system, taking into consideration the complex multi-domain nature of socio-technical systems and the need to plan/prepare, absorb, recover, and adapt to known and unknown threats. Using tools from Network Science, we present a method and a case study to model these systems by representing each specific domain as a single network that depends on the many networks around it, and show a method for quantifying integrative system resilience.

Resilient design of critical infrastructure systems

Massaro, EM*; Ganin, A; Steen, A; Collier, ZA; Kott, A; Gutfraind, A; Linkov, I; Risk and Decision Science Team, US Army Engineer Research and Development Center, 696 Virginia Rd., Concord, MA 01742; Department of Civil and Environmental Engineering, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA 15213; ema.massaro@gmail.com

Quantifying Resilience of Critical Infrastructure Systems

Our society is highly dependent upon an increasingly connected network of infrastructure, technological, and social systems which is vulnerable to man-made and natural disruptions. As a result there have been numerous examples where a local disturbance has lead to the global failure of such complex systems. We have previously argued that in highly complex and unpredictable systems such as these, coping strategies must move away from traditional risk-based approaches and towards a resilience-based approach. While resilience is not a new notion, previous studies of resilience only applied to a limited setting and generally focused on the effect of network topology. Here we aim to provide a mathematical formulation for quantifying the resilience as a property of the interdependent system. We introduce a novel approach for defining resilience that takes into consideration the complex multi-domain nature of cyber-physical systems represented. In this approach the nodes in the networks are linked through supply and demand relationships in a multi-level directed network. Our approach quantifies the four operational states of the system: normal operative phase during which all the nodes are active; absorption phase where the established supplier relationship are damaged and the damage propagates; recovery phase in which agents can find an alternative supplier; and the finally restored phase in which the damaged nodes are restored. We present computational results and matching comparison between analytical results and show that there is a nonlinear relation between supply redundancy and resilience where it is possible to exponentially increase the resilience of a system through a slight change of the local redundancy. These findings could facilitate evaluation and improvement of the resilience of infrastructure systems to cyber-physical threats.
Informing Climate Risk Management Strategy Decision Tools Using the Mental Models Approach

As we plan for future climate change scenarios, how should the tradeoffs among climate risk management strategies (i.e., mitigation, adaptation and geoengineering) be considered? This paper describes the mental models, or how one thinks about a topic, surrounding this question for eleven subject-matter experts in fields ranging from climate science to uncertainty quantification to ethical/epistemic analysis. To obtain these mental models, we conducted and qualitatively analyzed semi-structured interviews with each expert to obtain an influence diagram of their relevant decisions, and the uncertainties, factors and values influencing those decisions. We found that two iterative decision processes characterize expert mental models: decision structuring (how to structure computational models to analyze strategy impacts such as defining model inputs and objectives) and decision-making (how to make decisions about the strategies based on model results such as interpreting results or making judgments about the model itself). Within these mental models, strategy attributes (e.g., effectiveness, costs, risks) have varying levels of influence on these decisions. Furthermore, ethical values (i.e., those guiding how we should act) and epistemic values (i.e., those guiding what we can know) play an explicit role in decisions surrounding the evaluation of climate management strategies. For instance, the decision of defining model objectives is most influenced by considerations of welfare and distributive justice (ethical values), while the interpretation of model results is most influenced by the model’s consistency with scientific evidence and theories (epistemic value). The mental models developed as part of this work will inform the design of future computational models and decision tools to assess climate management strategy tradeoffs.

Communicating about diseases in the ocean: The effect of message frames on marine policy support

Oceans are suffering from the dual climatic pressures of warming temperatures and acidification, increasing the presence of disease risks that affect marine organism and public health. In this study, we examine the effects of communicating about risks to marine organism and public health on people’s support for policies aimed at mitigating those risks. We conducted a 2x2 field-based randomized experiment to examine people’s responses to messages that varied the causes and consequences of these risks. To maximize the salience of these issues, we focused our messages on oysters and recruited participants from ferry passengers (N=543) in the San Juan Islands of Washington State in the summer of 2013. Participants were randomly assigned one of four fictitious news articles detailing the ocean’s temperature rise and acidification in the Pacific Northwest. The article attributed the causes either to “global warming” or “climate change” and the consequences as primarily either to oyster health or public health. Our results found that participants who read the message highlighting oyster health and attributing it to global warming showed greater support for policy to mitigate marine risk and climate change, even among respondents who showed lower biocentric (i.e., environmental) values. The analysis further showed that participants’ perceived risks associated with the increasing prevalence of oyster disease was fully mediated (i.e., explained) the message effects on marine policy support. In contrast, the message emphasizing public health risks did not increase risk perceptions or policy support among participants lower in biocentric values, irrespective of whether the changes were attributed to global warming or climate change. We discuss implications of our findings for risk communication about ocean health in the context of a changing climate.

Is anyone developing a vaccine for better Ebola risk communication?

In March, 2014 the largest outbreak of Ebola ever seen began in West Africa. The Centers for Disease Control (CDC) and others began a campaign to reassure the American public that “it can’t happen here”. We were told that virtually “any hospital in America” could treat a patient with Ebola. That turned out not to be the case. On September 25th Thomas Eric Duncan, recently arrived from Liberia, was seen and discharged from the Emergency Department at Texas Presbyterian Hospital in Dallas. When Mr. Duncan was seen again on September 28, he was diagnosed with Ebola and admitted to the hospital where he later died. After transmission of the disease to two of Mr. Duncan’s treating nurses, a predictable erosion of confidence followed. To make things worse it was election season and politicians rushed into the credibility vacuum. State governments set up quarantines for those returning from Liberia, Sierra Leone, and Guinea without consideration of the likelihood of transmission. A returning nurse, remanded to a tent on her return from West Africa, stated that instead of an “abundance of caution” she had been subjected to an “abundance of politics”. How might we optimize the communication about Ebola if we had a chance at a do-over? In this presentation, the concept of outrage, its relationship with risk and hazard, and components of credibility are reviewed. The botched communication need never have happened, and we will outline how it could be avoided using the tools of risk communication developed by Dr. Peter Sandman, Dr. Vincent Covello, and others.

How can Europe achieve the California standard of vehicle emissions?

Fuel efficiency has historically been a European policy priority and has formed the definition of ‘green vehicles’ in a European context, more so than addressing health-related air pollutants from vehicles. Yet, recent studies show that poor air quality is now the number one environmental cause of premature death in Europe, with a toll that outstrips road traffic accidents, prematurely killing over 100,000 people a year. Vehicle emissions have been shown to be a significant source of this air pollution, identified as the third largest source of particulate matter (PM) and the main source of the ozone precursor gas - nitrogen oxide (NOX). Furthermore, diesel vehicles are responsible for up to 30 times more PM and NOX than petrol vehicles. At present, the US state of California’s vehicle emission standards are generally considered the most stringent in the world, with many arguing that they set the bar in terms of global leadership in tackling such air pollution. Given Europe’s current position as world leader in many areas of environmental policy, there is a strong case for European policy makers to attain this same achievement in addressing health-related air pollutants from vehicles, particularly in light of recent studies and growing public awareness and concern. The presenter will discuss the historical evolution of regulations governing the lead content of gasoline in the US and Europe and whether this could be used as a potential model for leadership; in addition to discussing the different barriers for Europe, including the current public concept of ‘green vehicles’.
Peer Engagement and Transparency in Comparative WOE Analysis for Mode of Action

Frameworks for Mode of Action (MOA)/Adverse Outcome Pathway (AOP) analysis were developed originally principally as a basis to increase transparency in consideration of weight of evidence to support a hypothesized MOA in animals or its relevance to humans. While framework analyses do not address the question of “what constitutes adequate weight of evidence (WOE) for acceptance”, their organizing construct contributes to consistent consideration of relative weight of evidence among different cases and hypothesized MOAs. This presentation introduces and illustrates the common template for consideration of the information on weight of evidence on hypothesized MOAs/AOPs which has evolved in recent international initiatives as a basis to solicit input from the audience, in the collective wisdom exercise. It will be illustrated through example based on analyses of a published assessment for a substance with several hypothesized MOA(s) for cancer. The WOE for each hypothesized MOA is summarized in narrative tables based on comparison and contrast of the extent and nature of the supporting database versus potentially inconsistent or missing information. The comparison is based on evolved Bradford Hill considerations rank ordered to reflect their relative contribution to WOE determinations of MOA taking into account increasing experience in their application internationally. The potential role of “collective wisdom” in WOE analysis for MOAs and AOPs based on experience internationally will also be considered. This includes its consideration in relation to current peer engagement models at various stages of the development and analysis of MOA/AOPs.

Challenges in deriving causal relationships from field observational data: a case study in West Virginia headwaters

Stream biota are subject to a diverse and complex set of environmental influences and stressors. Deriving benchmark standards aimed at protecting these biota should be based on well-supported causal inferences which link degraded biological condition to particular stressors for which standards are developed. Unfortunately, understanding and teasing out the individual influences of these overlapping, interwoven, multi-scaled environmental factors based on field biomonitoring data alone is a challenging task. One methodological challenge in creating environmental benchmarks stems from the fact that biomonitoring data collection programs are rarely designed in such a way as to enable statistically valid inference along specific stressor gradients. If multiple stressors are changing simultaneously, then endpoint response cannot be confidently attributed solely to one of those stressors. We present a case study for which observational data collected by the West Virginia Department of Environmental Protection was used to attempt to understand the relationship between conductivity and aquatic macroinvertebrate presence and abundance. These data exhibit (1) statistical confounding between the effects of conductivity, water temperature, and habitat, (2) ecological confounding in the sensitivity of the same insects to a wide variety of stressors, and (3) differences in data quality and measurability between possible predictors. Given these limitations, care must be taken when using data collected for a different purpose to infer causality in the context of ecological interconnectedness.

Wrap-Up: Comments from A Practitioner

This talk will bring together key themes from the session and offer insight into the use of Adaptive Management from world of federal regulation and oversight.
**P.159** Middleton, JK*; Richter, BP; Battelle Memorial Institute; middletonj@battelle.org

**Inclusion of Biological Agent Decay and Microbial Growth in the Terrorism Risk Assessment Food Consequence Model**

The Department of Homeland Security Terrorism Risk Assessment (TRA) programs use a model of ten representative foods to estimate the risk associated with intentional contamination events. First implemented for the 2012 Chemical Terrorism Risk Assessment (CTRA), this model has now been incorporated into the Bioterrorism Risk Assessment requiring the addition of biological agent decay and microbial growth considerations to the model. We will present the approach used for including biological agent decay and microbial growth and provide examples of the data used to support their parameterization.

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**W1-A.4** Mikami, Y*; Zhang, K; Nagaoka University of Technology; mikami@kis.nagaokaut.ac.jp

**Evaluation of the Risks of Unfinished Recalls**

The oldest product was made more than thirty years in Japan. Currently more than thousand recalls have not been completed, in another word, there remains unknown number of recalled products have not been recovered from the market. To complete the recall, the responsibility of consumers is crucial and caused by those products, manufacturers and government authorities including Consumer Affairs Agency (CAA) and the Ministry of Economy, Trade and Industry (METI) are spending big amount of time and money for publicizing recall notices. Publicizing efforts include notice through media, visits to possible owner families, communications and interactions with retailers, etc. In order to reduce the cost of these efforts and improve the effectiveness and efficiency of recall-related activities, an evidence-based, realistic risk evaluation is really needed. Major uncertainties here are questions such as how many products are still remaining in the market, which channel works most efficient to reach to the possible owners. The authors propose an information extraction methodology to answer to these questions by utilizing several existing government statistics in Japan. Statistics Act of Japan allows publicly funded researchers to access to original survey data to recompile the survey data to answer to their original questions, when the objective of their study is considered valuable for the public. The authors exploit this access opportunity to data-mine useful information, such as estimated life-curve and owner profiles (age, family type, locations of residence, etc.) of selected products. While the coverage of products is not satisfactory and various other limitations exist, the data-mining from the existing sources proves to be the most reliable and efficient way to improve the recall activities of both manufacturers and government authorities.

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**W3-K.4** Miller, S; Kidd, G; Montalto, FA; Gurian, PL*; Worral, C; Lewis, R; Department of Civil, Architectural, and Environmental Engineering, Drexel University; ggurian@drexel.edu

**Perceptions of climate risks and adaptation strategies in the New York metropolitan area after Superstorm Sandy**

Adapting to climate change will require deliberation and consensus development among many different societal groups. This study elicited views on climate risk and adaptation strategies from stakeholders in the New York City Metropolitan region in the months following Superstorm Sandy. Stakeholders included the general public and a group of “experts” consisting of regional scientists, government officials, engineers, and architects working actively on related topics within the region. Semi-structured interviews were conducted with the regional “experts” to identify climate change risks and adaptation strategies for the New York City area. Knowledge gleaned from these interviews was then used to create a structured survey, subsequently distributed to a larger group of 100 experts and 250 residents of coastal NY and northern NJ counties. In the survey, both stakeholder groups were asked to choose the top three climate threats to the NYC region, and to rate adaptation and mitigation strategies on a 1-5 Likert scale according to their perceived cost effectiveness and ability to protect the region. The results show that experts and residents agree that sea level rise, coastal flooding and storm surge, and an increased frequency and intensity of extreme events pose the greatest threats to NYC over the next 25 years. While both groups showed a preference for long-term planning over immediate action, experts and the general public did not agree on which specific strategies would best serve the region. The use of physical barriers to stop storm surge was rated higher by the public than by experts, while a retreat from the coastline was rated higher by experts than the public. Further work is needed to determine if these differing views persist over time and whether engagement with other stakeholders can reconcile these views to identify consensus plans for adapting to climate change.

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**T3-D.2** Miller, TH; Paap, SM*; Wyss, GD; Guzman, KD; Sandia National Laboratories; millert@sandia.gov

**Risk Metrics for Chemical Facility Security**

The Chemical Facility Antiterrorism Standards (CFATS) program is a risk-based regulatory program aimed at reducing security risks at our Nation’s highest risk chemical facilities. This program is led by the Department of Homeland Security (DHS). Over the past two years the authors have been working with DHS to develop metrics that can be used to evaluate and communicate the risk mitigation impact of the CFATS program. There are three key challenges in developing metrics to measure the impact of security risk management at chemical facilities. First, CFATS addresses a vast and diverse set of facilities ranging in size from Fortune 500 chemical companies to small, family-owned businesses, and spanning a broad range of functions from research and development, to production, storage and distribution, through end users of chemical products. The varied nature of the assets covered by the program poses a challenge to developing a meaningful metric of facility risk reduction. Second, there are a number of stakeholders engaged in the program including investors and owners in private industry, government entities, and community members. Clear communication strategies are needed to describe the CFATS risk impact and value across this disparate stakeholder group. Finally the risk methodology and metrics must be agile to accommodate the changing risk landscape of the chemical sector. Not only is the threat dynamic, but the chemical sector is ever evolving based on economic, and technology drivers. This presentation will provide an overview of the effort to develop risk metrics and associated analytical tools in light of these challenges for use in the CFATS program.
**P.91 Miller, Thomas A, TM; ZMassociates Environmental Corporation; thomas@zmassociates.com**

**The Risk Based Sustainability Project - the Project Based Learning Approach**

A well organized and well run sustainability project can improve organizations and communities in a way that breeds more positive change so a seemingly small project can, in time, become a force for much larger change. Sustainability projects have the potential to transform a community or an organization by uniting people in a common cause, by not only showing the way, but involving people in improving environmental, social and economic conditions. The goal of this model is to provide a framework to: • Identify and prioritize sustainability projects based identified and perceived risk, on need, critical success factors, and resources. • Obtain high level public/private sector sponsorship. • Identify resources (public and private), stakeholders, community stakeholders, and project management/leadership staff. • Provide cross-function team approach to cement buy-in and commitment. • Provide teaching and learning opportunities (remove barriers to listening). • Initiate and manage projects. • Document projects. • Communicate projects in a way to stimulate additional projects. • Provide resource library of ideas for other projects. Stimulate smaller organization or community project cells. • Provide cross-function team approach to cement buy-in and commitment. • Provide teaching and learning opportunities (remove barriers to listening). • Initiate and manage projects. • Document projects. • Communicate projects in a way to stimulate additional projects. • Provide resource library of ideas for other projects. 

**Elements of the Model and Cross-functional Team Approach**

- Identification
- Prioritization
- Resource sharing
- Community involvement
- Teaching/Learning

**T4-G.2 Mills, Karmann; RTI International; kmills@rti.org**

**Emerging Methods in Nanoinformatics: The Nanomaterial Registry’s Approach to a Sustainable Resource**

One of the most significant challenges to better-understanding the health and environmental implications of engineered nanomaterials (ENMs) is the fragmented nature of information and data spread across a growing and evolving body of literature. The expansion of research has naturally led to a substantial increase in information and data across diverse disciplines and located in various data sources. One response to manage this situation has been the development and maintenance of publicly-accessible databases to centralize and house data on the environmental, health, and safety (EHS) implications of ENMs, accessible to diverse stakeholder groups.

The National Institutes of Health (NIH) has created the Nanomaterial Registry through development by RTI International, as a central, publicly-available and authoritative repository of curated nanomaterial research data. As the NIH begins to specifically allow extra funds in grant awards toward the purpose of meeting their data-sharing requirements, the Nanomaterial Registry is poised to grow rapidly, with cutting-edge research information. The tools used for data sharing, related to current events in nanoinformatics will be discussed during this talk.

**P.134 Ming-Yen,Chien, *; Kuen-Yuh,Wu, ; National Taiwan University, Taipei, Taiwan; r02841014@ntu.edu.tw**

**Probabilistic Risk Assessment of 3-MCPD via Bayesian Statistics Markov Chain Monte Carlo Simulation.**

3-Monochloropropane-1,2-diol (3-MCPD) is one of several chloropropanols that can be formed in foods during processing, cooking and storage as a result of chloride ions reacting with glycerol and other lipids present in the food. Recently, study has shown that lots of ester-linked 3-MCPD are detected in fats and oils. These ester-linked 3-MCPD can release free form 3-MCPD directly into the food, or in the body after consumption. Due to the lack of consideration about the 3-MCPD ester hydrolysis, previous exposure values were underestimated. Considering the kidney is the main target organ for 3-MCPD in SD rats and that renal tubular hyperplasia is the most sensitive endpoint. The carcinogenicity test made by NITR (Cho et al.,2008) is applied to the Benchmark dose method (BMD) methodology to yield the predicted BMDL10 which is 0.87 mg/kg bw/day. The RFD is 0.0087 mg/kg bw/day by considering the UF of 100 for interspecies differences, and human variability in response. The main exposure route about 3-MCPD is food intake. We conducted the 3-MCPD concentration in different types of foods from other studies as a reference. Furthermore, the aim of this study is to consider 3-MCPD ester hydrolysis as a new exposure pathway. We use Markov chain Monte Carlo (MCMC) method via OpenBUGSv3.2.3 to construct the posterior distribution of the concentration. By means of this method, we can integrate the statistic prior into risk assessment process. This is the first article discussing the risk assessment of 3-MCPD in Taiwan. The mean 3-MCPD LADD of the consumer only data is 6.0076 mg/kg-day, the HI is 0.088, and the MOE is 1136. Due to the HI <1 and the MOE is larger than UF=100, the result may be associated with a low concern for health in 3-MCPD risk assessment. However, The regulatory agency still needs to develop the strategy to protect public health from intake of 3-MCPD in addition, further monitoring in various foods should be developed.

**T3-E.2 Mishra, A*; Lambertini, E; Pradhan, AK; University of Maryland; amishra1@umd.edu**

**Cost, Quality and Safety: A Nonlinear Programming Approach to Optimize the Temperature for the Supply Chain of Leafy Greens**

Leafy greens are well-recognized for their minerals, vitamins and dietary fiber content. Escherichia coli O157:H7 and Salmonella are two major pathogens which have been recognized as the cause of at least 10 known outbreaks related to leafy greens in the last 10 years in the U.S. Leafy greens are a perishable commodity, and generally their postharvest shelf life is one week. This study aimed to optimize supply chain temperature, taking into account cost of refrigeration, sensory quality (fresh appearance, wilting, browning, and off-odor), and microbial safety of leafy greens throughout the supply chain (processing, transportation, retail storage, and home storage) using nonlinear programming (NLP). Specifically, the model was applied to estimate the upper temperature limit to be maintained throughout the supply chain of leafy greens in order to minimize cost, to limit the growth of pathogens within specified risk-based parameters, and to control the loss of sensory qualities to specified levels. For determining the cooling cost, the coefficient of performance (COP) for refrigeration was considered. In this study, first, parameters of sensory quality loss function (Arrhenius equations) and pathogens growth models were derived from a systematic literature review, followed by the optimization of temperature. The objective function was cost, which was to be minimized. The nonlinear constraints were the growth of pathogens (E. coli O157:H7, and Salmonella), and the loss of sensory characteristics. The model was run for different scenarios, and results were obtained for a range of constraints. The constraints were that the growth of E. coli O157:H7 and Salmonella should not be more than 0.5 or 1 log CFU/g, and none of the sensory attributes should fall below 50% or 75% of the initial value (sensory score). On the basis of the scenarios considered, the results suggest that the maximum harvest-to-consumption time should not be more than 7 days.
P.169 Mlakar, J.; Johnson, R; Gustafson, L; Thometz, E; Losapio, C; USDA APHIS Veterinary Services; joseph.a.mlakar@aphis.usda.gov
Assessment of the Impact of the Federal Order in Reducing the Risk of Exposure of Live Freshwater Fish Species in the United States to Viral Hemorrhagic Septicemia Virus (VHSV-IVb)
This analysis assesses the impact of the USDA Animal and Plant Health Inspection Service (APHIS) Federal Order (April 2, 2008) in reducing the risk of exposure of live freshwater fish species in the United States to Viral Hemorrhagic Septicemia Virus (VHSV). VHSV causes viral hemorrhagic septicemia (VHS), a highly contagious viral disease of freshwater and marine fish. The Federal Order instituted domestic movement restrictions applicable to 28 known susceptible fish species. In this analysis, we divide the United States into 499 Risk Areas of Interest (RAIs) using information on watershed and State boundaries. For each RAI, we estimate the relative risk of exposure of live freshwater fish species to VHSV using qualitative and quantitative evaluations of risk factors. The end result is a matrix of scores that are aggregated to determine the overall relative risk estimate for each RAI. We also re-compute the overall relative risk estimates without the VHSV Federal Order to observe how the overall relative risk changes if the movement restrictions under the Federal Order are removed. Four percent of the continental United States (by area) is currently considered to be in a VHSV-affected area. With the Federal Order in place, 11.5 percent of the United States has a risk of exposure at least as high as the VHSV-affected areas and 13.1 percent of the United States has a risk of exposure approximately 10 times less than the VHSV-affected areas. In total, these three risk categories make up almost 25 percent of the United States. Without the Federal Order in place, very few RAIs increase in risk levels. In the continental United States, 23.8 percent of the area is in the top three risk categories with the Federal Order, compared with 25.7 percent in the top three risk categories without the Federal Order. Therefore, removing the restrictions in the Federal Order would not significantly increase the overall relative risk of VHSV.

M2-A.4 Montoya, M*; Mazzuchi, T; Sarkani, S; George Washington University; mattsleague@comcast.net
Framing Critical Infrastructure Resilience Functional Requirements Using Model-Based Systems Engineering
The recent emphasis on critical infrastructure resilience has generated a large number of frameworks, concepts, metrics, and modeling-analysis approaches. Sifting through the many different approaches and perspectives can be overwhelming as the many different concepts, there are differing lexicons, taxonomies, and ontologies from which to view and assess resilience. The purpose of this paper is to begin to work towards a more systems engineering centered resilience approach by defining and analyzing resilience in the context of a standard systems engineering lexicon and modeling tool-set. Specifically, this paper will differentiate physical and functional resilience requirements for critical infrastructures. This subtle but important differentiation of requirements enables better defined, parsed, and allocated requirements. A specific example of a port critical infrastructure transportation system will be used. The port’s critical infrastructure resilience will be defined in common systems engineering terms and the analysis will be carried out to quantify the functional resilience of the system. Once the port example is parsed into measured systems engineering terms, the critical infrastructure use-case information, functions, and metrics will be transferred to an integrated mathematical modeling and model-based systems engineering construct for analyses and trade-studies. With the port scenario information in an integrated modeling construct, network mathematical programming, queuing analysis, and uncertainty analysis will be conducted to generate solution options and demonstrate interdependencies to improve resilience and show system impacts. The coupling of the mathematical model techniques with the model-based systems engineering approach will provide a more structured, intuitive, and accessible solution trade-space along with more understandable CI interdependencies, output solution recommendations, and system impacts.

T2-A.4 Mokhtari, A*; Beaulieu, S; Little, K; Oryang, D; RTI International; amokhtari@rti.org
A novel risk-based approach to inform food safety decision making
Making food safety resource allocation decisions can be a daunting task that can be informed by understanding the trade-offs between benefits and risk reduction while considering associated costs. Decision makers may be faced with balancing a variety of concerns when considering the range of possible choices. Increasingly, there is a desire to have and use a decision-making process that is transparent and reproducible. As a part of a data-driven integrated decision support system, RTI (under contract with FDA) developed a flexible tool--referred to as iOptimize--that facilitates allocation of resources between and among a range of decision options, considering a set of predefined goals (e.g., minimizing cost, minimizing the burden of the foodborne disease) and different decision criteria (e.g., cost, risk reduction, practicality, feasibility). iOptimize allows the user to define a specific scenario (e.g., allocating resources among research projects or sampling activities) and upload available supporting data using .csv files. The user can further adjust and define several constraints around the resource allocation problem (e.g., cost not to exceed the annual budget). The tool implements a Genetic Algorithm (GA) approach to identify the optimal allocation of resources between available decision options and further facilitates mapping decision options to different resource categories (e.g., research, surveillance, and outreach) allowing determination of which resource category is associated with the most cost effective risk reductions.

P.69 Moolgavkar, SH; Chang, ET; Watson, HN*; Lau, EC; Exponent, Inc.; hwatson@exponent.com
Cancer mortality and quantitative oil production in the Amazon region of Ecuador, 1990–2010
Purpose: Controversy persists over whether cancer risk is increased in communities surrounding oil fields, especially in the Oriente region of Ecuador. This ecologic study uses quantitative measures of cumulative oil production and well-years. Regression was used to estimate mortality rate ratios (RRs) adjusted for age and sex. In a two-stage analysis, canton-specific log-RRs were regressed against quantitative estimates of cumulative barrels of oil produced and well-years. Conclusions: Results from this first ecologic study to incorporate quantitative measures of oil exploration and production activities on cancer mortality rates in the Oriente region of Ecuador. This ecologic study uses historical data on oil production to estimate the association of cumulative oil production and well-years with acute non-lymphocytic, myeloid, or childhood leukemia.

December 7-10, 2014 - Denver, CO
Wireless Telecommunications Facilities - Risk Assessment, Perception, and Communication

The use of and reliance on mobile devices and technologies has become a way of almost all facets of everyday life. To accommodate the growing demands for wireless services - communications and various types of high speed data transfers - the number of base station antennas on cell towers, rooftops and other structures, and in buildings continues to increase rapidly. Only a short time ago, the commercial wireless carriers focused the siting of base station facilities in communities to provide an initial footprint of coverage. Today, increases in call and data traffic (and consumer demands) has shifted focus to capacity, where supplemental cell sites and upgrades of early generation equipment are increasingly being deployed in many markets. This presentation provides a general overview of the evolution of wireless technologies in the U.S., and highlights emerging technologies used by the major wireless carriers to meet demands. The roles of lead community agencies (such as municipal Planning or Zoning Boards) tasked with conducting “due diligence” reviews of proposed wireless telecommunications facilities are discussed, including the elements of interest to the citizens these agencies represent. In terms of risk assessment and risk perceptions, health and safety considerations such as radio frequency (RF) emissions will be presented, including a summary of industry and independent studies of potential exposures and health effects associated with base station facilities. Federal Laws - and their interplay with local reviews and decision making - continue to present interesting challenges to lead agencies and risk communication.

Regulatory approaches to synthesis of scientific evidence in decision-making

Science and policy intersect in federal rulemaking. Scientific evidence is needed to support decisions that mitigate human exposures to chemical and microbial hazards associated with food production. A multidisciplinary approach to identify and characterize public health risks may be best suited to solve public health and environmental issues associated with the food system.

Panel Discussion

The era of transparency poses unique challenges to regulatory agencies, industry, and academics. A panel of speakers from the symposium will discuss transparency in the context of effective risk communication, particularly regarding the role of expert judgment in the risk or safety assessment of food additives and ingredients.
**P.58** Naito, W; National Institute of Advanced Industrial Science and Technology; w-naito@aist.go.jp

**Assessing Doses from External Radiation using a Personal Dosimeter in Areas Affected by the Fukushima Daiichi Nuclear Plant Accident**

To effectively and appropriately manage external radiation doses in the affected areas of Fukushima, it is important to identify when, where, and how much exposure occurred. It is also necessary to quantitatively measure external exposure and air dose rates for different activity patterns of individuals. We used a new personal dosimeter (D-shuttle) along with a global positioning system (GPS) and geographical information system (GIS) to relate personal dose rate with activity patterns and air dose rate. Hourly individual doses obtained by D-shuttle can provide an effective communication tool for those who want to identify when and how much exposure occurs. Personal monitoring of more than 50 volunteers showed that personal doses obtained from D-shuttle were well below the cumulative air dose estimated by data from the airborne monitoring survey. Our analysis showed that the external exposure from staying at home represented about half of the total cumulative dose. This suggests that even the peak exposure doses may be observed outside of working hours, to develop appropriate countermeasures for external dose reduction, it is important to identify the contributions of individuals’ time-activities to the total dose. Our study provides a valuable basis for developing a pragmatic method to estimate external doses of individuals in Fukushima.

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**P.123** Nance, P*; Cockrell, G; Toxicology Excellence for Risk Assessment; Health Canada; nance@tera.org

**This is the titleReview of Tools used by National Regulatory Authorities and International Chemicals Management Authorities to Communicate Chemical Risk Information to the General Public**

Health Canada, in conjunction with Toxicology Excellence for Risk Assessment (TERA), investigated the types of publications made by other national authorities and international agencies involved in the management of chemical substances, including an environmental scan of the types of publications that are publicly available and a comparison to the current “public summary” documents published under the umbrella of the Chemicals Management Plan. One of the primary goals of the Chemicals Management Plan was to enhance risk communication for Canadians. The intent of the public summaries was to address this commitment. The purpose of this review is to develop a comprehensive inventory of publicly available documents whose primary purpose is to inform the general population about the health risks posed by chemical substances that have been assessed by national and/or international regulatory authorities; and compare the Canadian Chemicals Management Plan public summaries to similar materials from other jurisdictions. The two main objectives were to compare and analyze representative Canadian Public Summaries with representative publications from other agencies to determine the appropriateness of the language used to provide material that is understandable for a non-technical audience and include recommendations for improving the quality and effectiveness of the public summaries as outreach tools.

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**P.124** Nance, P; Toxicology Excellence for Risk Assessment; nance@tera.org

**Common Language: An Analysis of Communicating Children's Health Risks to the Public**

KidsChemicalSafety.org is a website for scientific outreach to parents that strives to provide up-to-date health information on chemical hazards and safe use of chemicals around children. It features articles on hazards around the house, in food, and in consumer products, and offers readers the opportunity to submit their own chemical safety questions. Scientific information should be written at an 8th grade reading level so the majority of the general public will understand the information. There are many challenges in communicating the human health risks to children from chemical exposure. The website has been active since the Fall of 2012, the presentation will highlight some of the risk communication challenges found in communicating to the public, as well as, the approaches incorporated to ensure the website serves as an effective communication tool for the public.

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**W4-E.3** Nance, P*; Farland, W; Simon, T; LaKind, J; Toxicology Excellence for Risk Assessment; nance@tera.org

**3) Presenting Uncertainty in the Context of Biological Monitoring and Exposure Information**

Appropriately designed visual aids can improve comprehension of risks associated with different medical treatments, screenings, and lifestyles. Often, individual and societal risk-based decisions stem from anecdotal narratives. Visual aids also foster appropriate risk-avoidance and healthy behavior—hence, these aids reduce decisions errors. As demonstrated with specific examples, a series of figures is used to display relationships between toxicologic/epidemiologic endpoints and potential for human risk. These figures are meant to convey in an easy-to-understand way the relationships between toxicologic/epidemiologic observations, data uncertainty and variability, commonly used risk metrics (e.g., RfDs, ADIs, RSDs) and estimates of potential exposure. In addition, the approach can include information on guidance values developed by other countries/authorities, which gives the audience an understanding of how the same underlying database can yield different guidance values. The final figure in the progression shows how guidance values can be portrayed within the context of biomonitoring information, derived from NHANES. This approach is likely to have significant value to risk managers and members of the public who are not as well acquainted with the risk assessment process, its uncertainty and variability, and its role in the risk management process.
Having a reliable electric power is crucial for proper function of our society. Each year, the coastal power distribution systems in the U.S. are stressed by hurricanes. They cause widespread and prolonged outages that often lead to huge economic losses. Experience and research has shown that tree-trimming practices of power utility companies are an important factor in the extent of hurricane-induced outages and outage durations in overhead power systems. In this talk, we describe the results of our decision analysis model used to assess the costs and benefits associated with investing in vegetation management for electric power networks and discuss further studies needed to address this research question.

**W3-C.5 Nateghi, Roshanak; Johns Hopkins University; rnateghi.1@jhu.edu**

**Risk-informed investment decision frameworks to mitigate the impacts of disasters on power systems**

A prescriptive multiattribute model of user preferences for conflicting objectives related to cyber security risk

Multi-attribute utility (MAU) models are an effective framework for analyzing decision problems with multiple and conflicting objectives. MAU has been utilized to evaluate public policies across several domains, but its applicability to cyber security policy is unknown. Recently, cyber security has become a major concern for both users and policy makers because the arrival of the smartphone and other mobile devices increase the vulnerability of private information. Technologically, an improvement on protective measures against privacy threats (e.g. encryption) may reduce performance or increase cost, requiring trade-offs among multiple and conflicting objectives. Using the MAU framework, the current study aims at assessing how privacy is traded against other conflicting attributes such as cost, interface, speed, and availability of apps. We also examine how different privacy threats influence tradeoffs against privacy. The experiment is hosted in Qualtrics.com, with 300 respondents from Amazon Mechanical Turk. Respondents will be randomly assigned to one of four threat source conditions: governmental surveillance, criminal activity, marketing intrusion, or control group. Respondents responded to a series of binary choices between smartphones varying on two of the five attributes. Using an iterative choice procedure, a total of 10 trade-offs were obtained (involving all pairs of the 5 attributes), allowing for consistency checks. In each trial, two smartphone options are described on five features, where they are identical in three but different in the other two attributes. Respondents are asked to select their preferred option. The quantity of one of the two contrast attributes is adjusted to bound the trade-off between the two varying attributes. Respondents also answer several questionnaires at the end. Results from this study reveal how individuals value privacy in the face of cyber threats, and offer implications for the design of cyber security policy.

**M4-D.4 Nguyen, KD*; Rosoff, H; John, RS; University of Southern California; hoangdun@usc.edu**

**A Prescriptive Multiattribute Model of User Preferences for Conflicting Objectives Related to Cyber Security Risk**

**T3-H.1 Neal-Klueter, AP*; Aungst, J; Gu, Y; Hatwell, K; Muldoon-Jacobs, K; Liem, A; Ogunbesein, A; Shackelford, M; US Food and Drug Administration; april.klueter@fda.hhs.gov**

**Infant Toxicology: State of the Science and Considerations in Evaluation of Safety**

Infants (0-6 mo) experience a different exposure scenario to food contact migrants than adults. This time period is also characterized by important developmental changes. Safety assessment for infants should consider both exposure parameters as well as life-stage specific potential sensitivities.

**T2-J.8 Nicol, AM*; Ryan, A; Tunbridge, S; Okocha, B; Simon Fraser University; anicol@sfu.ca**

**Reporting Radon Risks: A Historical Analysis of the Media Coverage of Radon in Canada**

Objective: Radon gas is naturally occurring and causes problems when it builds up in indoor air environments. It is known to be the leading cause of lung cancer in non-smokers and the second leading cause of lung cancer overall. However in 2011, less than half of Canadians have ever heard of radon. The aim of this project was to investigate how radon gas exposure has been represented in the news since its presence was known in Canada. The goal was to capture the prevalence of radon coverage over time and how articles have been framed for readers. Methods: Newspaper databases were searched for stories on radon gas from the 1970s onward in Canada, including both daily and weekly papers. Inclusion criteria were broad to capture all relevant stories. All headlines were collated and charted to examine prevalence of articles over times. Thematic and narrative analyses were undertaken to examine framing and agenda setting. Press coverage was compared to maps illustrating high radon potential zones across the country. Results: Media stories about radon gas began in Canada in the late 1970s and focused on the issue of occupational exposure and compensation for miners. By 1981, articles began covering residential exposures studies. Over time, the coverage has shifted thematically from initial concern, to debates around scientific uncertainty, then reassurances about safety and returning to concern after guidelines were changes in 2007. The amount of coverage has varied considerably across the country, although results do not correlate with regions of where radon concentrations are higher. While initially described as “radioactive” in initial headline coverage, the term was dropped until after the guidelines changes in 2007. Conclusion: This presentation concludes with a discussion of the media’s role in shaping Canadian actions around this important carcinogenic exposure and how coverage could be improved going forward.
Drinking Water Risk Assessment in the Developing Countries

Safe drinking water is still inaccessible for population in the developing world with about half of this population suffering from one or more of the diseases associated with water supply. In Africa the most common and deadly pollutants in drinking water are biological contaminant cause by microbial and viral pathogens due to poor sanitation, hygiene and or level of water supply access, and chemical contaminants due to industrial waste and dumping of chemical waste by the developed countries on African coast. The World Health Organization (WHO) promotes the use of risk assessment coupled with risk management for the control of water safety in drinking water supplies. Risk assessment talks about exposure assessment, dose-response analysis and risk characterisation and has to do with statistics, unfortunately there are little or no data to work with in Africa. In many cases, improving the microbial quality of water may have less impact on disease than investments in sanitation, hygiene or level of water supply access. Securing our boarders and creating awareness on the impact of industrial waste may also improve water quality in the developing countries.

Cost-benefit analysis of the countermeasures for agricultural products against contamination with radioactive substances

On the agricultural lands contaminated with radioactive caesium released from Fukushima Daiichi nuclear accident, countermeasures have been taken for preventing products from containing radioactive caesium exceeding the food standard, 100 Bq/kg. In this study, costs per life-year saved (CPLYS) are estimated for the countermeasures in the production and the delivery of rice and anpo-gaki (dried persimmon). Fertilization with potassium and zeolite, and deep cultivation were carried out to prevent rice from absorbing caesium. Total inspection was then implemented to stop the delivery of contaminated rice. The cost for the former measure was 870 thousand yen/ha or 200 yen/kg-rice. This measure is assumed to have reduced caesium concentration in the rice grown in the areas that had produced rice with more than 100 Bq/kg caesium in 2011 to below 100 Bq/kg according to the distribution observed in 2012. The amount of reduction is from 58 Bq/kg to 180 Bq/kg, resulting the value for CPLYS, 0.29 to 1.0 billion yen. Total inspection costs 6 billion yen per year, which detected 71 bags of rice with concentration above 100 Bq/kg. The detection reduced intake of radioactive caesium by 120 kBq, which would have saved 0.0019 years of life, resulting the value for CPLYS, 3.0 trillion yen. Persimmon trees were decontaminated in winter from 2011 to 2012 to reduce caesium in anpo-gaki. This countermeasure costs 70 million yen and reduced the average concentration in anpo-gaki from 180 Bq/kg to 130 Bq/kg in 2012 and 140 Bq/kg to 71 Bq/kg in 2013. If anpo-gaki were delivered and eaten from 2012 to 2022, the life-year saved by the decontamination would amount to 15 years, which would bring about the value for CPLYS at 48 million yen. Distribution for sale for anpo-gaki was stopped in 2012, resulting the value for CPLYS at 560 million yen. The strict standard for caesium contamination in food has caused inefficient countermeasures taken in agriculture.

Complexities of Environmental Risk Factors and Public Health

Over the past century, investments in medical research have led to remarkable progress in improving the health and quality of life of the American people. The WHO estimates that the environment causes over 25% of disease and death globally; therefore, environmental protection has and will continue to play a major role in reducing the burden of human morbidity and mortality. To make further improvements in public health through environmental protection, we need to make better use of new science and technologies to improve environmental health decision-making. Complex human-environment interactions require a more holistic or systems approach, and we cannot continue to focus on one chemical at a time and non-chemical stressors must be taken into account. As our understanding of human biology has grown, the scale and diversity, size, and complexity; we are more dependent on systematic review and data-integration tools to ensure that IRIS assessments are based on the best scientific evidence available and that analysis and interpretation are objective and transparent. Therefore, we are in the process of developing a “set of decision rules” for identifying, evaluating, and quantifying risk. This requires an operational framework involving stakeholders, where specific questions are formulated, relevant evidence is collected and systematically evaluated. We can no longer rely solely on expert judgment and unstructured search and analysis of large and multiple data sources.
P.103 Ono, K*; Tsunami, K; National Institute of Advanced
Industrial Science and Technology (AIST); kyoko.ono@aist.go.jp
Preliminary survey on public acceptance of hydrogen
fueling station in Japan

Hydrogen storage facilities, such as hydrogen fueling station
(H2 station), are inevitable infrastructure for the utility of fuel
cell vehicles. Goal of our research project is to provide a risk
communication study to support for initial market introduction.
In this research project we are planning to a pilot risk
communication study, in which we will present quantitative risk
information to public under the scenario that H2 stations are
widely introduced at 2030. The information includes reduced
risk on air pollutants’ exposure (SOx, NOx, ozone), reduction on
global warming gas (carbon dioxide), and probability and
severity of accidents on H2 stations. Then we will try to survey
a change in risk perception before and after the risk
information is provided. As preliminary survey, we conducted
two online surveys (N=2,000 for both surveys). The one is a
survey on risk perceptions toward 20 objects (such as disasters
including explosion or burning H2 stations and gas station,
substances, and technologies), to construct a cognitive map
for Japanese people. We provided only qualitative information
on the objects to participants, and the participants answered
based on their existing image, with a 7-point Likert scale.

The results showed that people had the higher level of unknown
among “explosion or burning of H2 stations” than that of gas
station, however, people had same level of dread toward these
two disasters. The other online survey was to investigate a
relationship between the acceptance of H2 stations and risk
perception. 70% of male and 60% of female agreed with
installation of H2 stations. Participants who lived apart from gas
stations (more than 1 km) tended less acceptable of H2 stations
and they had stronger intuitive dread or feeling of lacked
knowledge about H2 station. This indicates that
cognition of H2 stations might be constructed according to an
analogical image of gas stations.

P.186 Ollison, W*; Johnson, T; Capen, J; API; ollisonw@api.org
Regulatory Ozone Risk Assessment Sensitivity to
Improved Exposure and Response Models – II.

We evaluate the sensitivity of EPA’s zero-dimensional ozone exposure
model (APEX) to (1) additional alternative pulmonary function
response models, (2) attainment air quality (AQ) rollback
approaches, (3) monitor inlet height/altitude bias effects, and
(4) newly measured ozone penetration/deposition rates and
microenvironmental (ME) factors, corrected for ozone
measurement error. Results are provided for Denver AQ
scenarios representing 2006 “as is” AQ conditions and the
attainment of the current ozone NAAQS. We test recently
published and refitted pulmonary function models that
incorporate realistic ozone response thresholds and subject
response variability proportional to the level of response. A
CAMx model is used to adjust 2006 Denver AQ to simulate
NAAQS attainment conditions. The modeled rollback
projections account for NOx control-related increases in urban
and background ozone levels from reduced NO-ozone titration
that are not addressed by EPA’s quadratic rollback approach.

Inhaled ozone mass is adjusted to account for monitor inlet
height bias and altitude acclimation among Denver residents.
Impacts of newly measured indoor ozone penetration-deposition
rates on estimated responses are compared to projections using
current APEX indoor mass-balance model assumptions. APEX
ME factors are also adjusted according to 2012-2013 field
measurements made in Durham NC using new interference-free
ozone measurement techniques. Three updated sensitivity
analyses test these updated components in the APEX exposure analysis are tabulated and
compared to those of the current APEX model.
Evaluating the Success of Science Festivals

Achieving public understanding and support has been a key issue for scientists. Without them any scientific innovation, particularly those involving potential health or environmental risk will face difficulty in garnering research funding and establishing perceived legitimacy with the public. Public engagement activities such as science festivals have therefore garnered attention as a tool to build favorable relationships between scientists and the public, although not many studies have evaluated the effectiveness of such events. This exploratory study assesses the impacts of a science festival on self-reported knowledge and interest in science, perceived fairness about scientists, and likelihood of supportive post-event behaviors, using an onsite questionnaire from a science festival at a U.S. university. The findings can be summarized as follows: when participants felt they had a positive experience and/or they engaged in activities at the festival, participants’ (1) knowledge and interest in science, (2) perception of fairness toward scientists, and (3) supportive behavioral intentions about similar events were enhanced. As for the influence of activity types on participants, direct interaction with scientists discussion with scientists), increased the probability of favorable attitude toward future events. Passive activities, such as listening to others discuss, were not related to changes in perceptions. These findings provide lessons for festival planners: First, planners must know the level of participants’ knowledge and interest in science. If they are not familiar with or they are not interested in science, positive impacts of the festival may be limited. Second, providing direct interaction between scientists and participants is a key for increasing “science festival” impact. Third, encouraging participants to engage in many activities may be important.

Revealing the Willingness To Pay for income insurance in agriculture

In spite of its minor and decreasing share in EU GDP, agriculture still plays a fundamental and strategic role in many areas of the economy. This is why the EU has put much effort during the last decades in guaranteeing a stable agricultural income. However, conventional income stabilization tools have been showing recently signs of exhaustion. Under this critical juncture, EU institutions have encouraged the expansion of agricultural insurance. With different degrees of public support, insurance systems against several risks have been successfully developed across the EU and have adopted increasingly comprehensive forms. Eventually, EU institutions have started to assess the development of a comprehensive income insurance framework. Income insurance covers a wider variety of risks and has higher costs and uncertainty than conventional single risk or combined yield insurance. This may result in a higher and even unsustainable demand for public support. Assessing and enhancing the sustainability of income insurance demands an in depth knowledge of farmers’ Willingness To Pay (WTP) for this product. The following pages present a methodology that calculates the WTP for different degrees of income protection using a Revealed Preferences Model and the Certainty Equivalent theory. The methodology is applied in a drought prone area in southeastern Spain. Results show that WTP for income insurance in this area is higher than observed insurance premiums of the most comprehensive policies currently available. This may play in favor of the development of more comprehensive income insurance systems, though additional evidence is required.

Visualization in Macropudential Risk Analysis & Decision Making

Macropudential supervisors face a daunting challenge in understanding the seemingly infinite stream of data, arriving at ever-increasing frequencies and spanning a wide spectrum of reliability. The recent crisis demonstrated that stakes are high. Visualization techniques can help channel the data fire hose into more useful information by succinctly revealing key patterns and relationships which human visual perception and cognition are adept at interpreting. However visualization is not a panacea. Poorly crafted visualizations can be confusing, distracting, or even misleading. More importantly, “visualization” encompasses a range of techniques with varying strengths and weaknesses. It is important to choose the right tool for the task at hand. Visualization requires wise thought as to how to clearly represent information such that knowledge can be built, similar to text or numbers selection. Our work looks at developing a framework for how regulators and policy makers should use visuals to examine risk for different financial markets and the larger economy. Through proper use of visual tools we believe that analysis and decision making can be performed in a clearer format that will reinforce traditional economic indicators and provided a better contextual understanding of the risks that underlie the US financial system.
Poultry meat, which constitutes a large portion of the American diet, is of great food safety concern as poultry has been recognized as a major reservoir for foodborne pathogens such as Salmonella and Campylobacter. The objectives of this study were to provide a review of QMRA models developed in recent years, and to summarize data and information that are available and identify data gaps that are needed for future research. A broad literature search was done, and QMRA models for both Salmonella and Campylobacter in poultry meat and poultry meat products developed in the United States, Belgium, Canada, United Kingdom, Denmark, the Netherlands and Sweden were compared and discussed. All models include some or all main stages of the poultry meat production chain: primary production, industrial processing, preparation, and consumption. The modeling approaches vary between these risk assessment studies, including the use of different growth and dose-response models. Cross contamination and undercooking are major concerns of the risk of pathogen contamination during consumer preparation stage. Intervention measures aimed at reducing pathogen concentration at retail level, reducing the incidence of undercooking, and appropriate handling of poultry meat and their products are effective in control the risk associated with Campylobacter and Salmonella in poultry meat. This review summarized existing models and available data for QMRA studies of Campylobacter and Salmonella in poultry meat. Critical data gaps such as pathogen behavior at primary production stage, and time/temperature data between processing and retail were identified. This study could serve as a useful resource for future QMRA works for pathogens in poultry meat.

Disinf ectant byproducts (DBPs) and herbicide Atrazine are commonly present in the community drinking water systems in US, particularly in the tap water. The USEPA and FDA have established a Health risk in humans. These methods are limited in scope because of inherent temporal-spatial variability, mixture interactions, and characteristics of water distribution networks. Therefore, we used a direct approach of collecting tap water samples from the residents to measure regulated DBPs (4-Trihalomethanes and 5-Haloacetic Acids), and atrazine in Indianapolis Community Water System (IndyCWS). The ten residential sites are identified to capture the large part of IndyCWS. We collect samples on weekly, biweekly, and monthly basis during the May-July period. The samples will be tested in a certified laboratory using EPA recommended methods. The exposure data from this study will be used to estimate precise community exposure and their association with health outcomes. Currently, this work is in-progress and the results from the study will be discussed in the meeting.

An independent expert panel met on March 31, 2014 in Charleston WV to review and discuss available toxicity data for chemicals released to the Elk River in January 2014 from a Freedom Industries facility. The panel was convened by Toxicology Excellence for Risk Assessment by the West Virginia Testing Assessment Project (WV TAP), an initiative funded by the West Virginia Governor’s office to provide expert advice to the State. A screening value of 1 ppm for 4-methyl-1-cyclohexanemethan (MCHM) was developed by the Centers for Disease Control and Prevention (CDC) on the day the spill was detected. Additional toxicological studies became available after CDC derived this screening level and the expert panel evaluated all the available data. The panel drew upon its collective expertise to recommend use of more refined methods to calculate short-term advisories applicable to human exposure situations of one day up to approximately three months. The panel included an adjustment to account for additional routes of exposure (dermal and inhalation). In addition, without information on what life stage is most sensitive to the effects of MCHM, they thought that the health advisory should be designed to protect the most exposed life stage that consumes the most water on a body weight basis, that is, a formula-fed infant of 1-3 months. The panel developed short-term health advisories of 120 ppb for MCHM, 880 ppb for propylene glycol phenyl ether (PPH) and 260 ppb for dipropylene glycol phenyl ether (DPPH). These advisories are intended to protect all portions of the population and for exposure from all routes. The expert panel also identified areas where further data and research are needed, including research on skin irritation, toxicology studies in pregnant animals, epidemiological analysis of exposure and health effects reports, and chemical fate and transport within the distribution system.
M3-I.2 paustenbach, Dj; Cardno ChemRisk; dpaustenbach@chemrisk.com

When using a risk based approach to setting OELs will work and when it won’t

The promulgation of new or revised federal occupational exposure limits (OSHA PELs) has been “stuck” for at least 25 years. And, the ACGIH approach to setting TLVs for the vast majority of chemicals has rarely relied to a significant degree on so-called quantitative risk analysis (QRA) methods. Thus, in the risk assessment community, there has been a haunting concern that workers and the public are not aware of the plausible magnitude of the probability of adverse health effects which “may” be present in some portion of the workforce if exposed to many of the PELs, TLVs or other occupational exposure limits (OELs). This paper will evaluate, by category of adverse effects, the plausible benefits of using QRA to establish OELs or at least inform workers of the possible magnitude of risk associated with various levels of exposure. The shortcomings of attempting to apply QRA methods “across the board” will also be discussed.

M2-H.1 Pearce, EN; Boston University School of Medicine; elizabeth.pearce@bmc.org

Impact of multiple goitrogen exposures during pregnancy

Environmental exposure to the goitrogen perchlorate, nitrate and thiocyanate is widespread. Goitrogen exposure is of particular concern during pregnancy, when thyroid hormone activity and an increased iodine demand play a critical role in neurodevelopment. Studies of thyroid hormone serum concentrations in pregnant women in Greece, Italy, Wales, and Israel indicate that low-level exposures to perchorlate are not associated with alterations in thyroid hormone serum concentrations. In contrast, recent work evaluating exposure to both perchlorate and thiocyanate during the first trimester of pregnancy in Thailand found a positive association between urinary perchlorate and TSH, a negative association between urinary perchlorate and FT4, and a positive correlation between urinary thiocyanate and TSH in women with low iodine. In Wales, an antenatal thyroid screening study found that maternal perchlorate levels in the highest 10% of the study population were associated with increased odds of offspring IQ being in the lowest 10% at age 3 years. Although perchlorate is a strong inhibitor of iodine uptake by the thyroid gland, exposure to perchlorate is relatively low; by contrast, thiocyanate and nitrate are weak inhibitors of iodine uptake, but exposure levels are much greater than perchlorate. Thiocyanate and nitrate thus contribute the vast majority of the body’s typical total iodine intake in iodine-deficient populations. Nitrate and thiocyanate intake also plays a critical role in susceptibility to goitrogens, and lowering goitrogen exposure in the absence of adequate dietary iodide will not protect the fetus from the effects of iodide insufficiency. These results suggest that we need to study the combined effects of concomitant exposures to multiple goitrogens and iodide status and raises questions about the effectiveness of regulating perchlorate without considering other exposures.

T3-J.3 Pearce, JM; Rogers, MB*; King’s College London; julia.pearce@kcl.ac.uk

Talking about lone-offender extremist events: the challenges and benefits of communicating about low probability high impact risks

Effective risk communication is an integral part of security and emergency response strategies, both in advance of, during and after extreme events. Miscommunication with the public can compound the negative impact of an event and impede the return to normalcy. Risk communication in the case of wilful, violent events, such as attacks carried out by lone extremists involves communicating multiple messages to diverse audiences, from the extremists themselves, to public audiences, to private and public stakeholders who might be encouraged to contribute to the defence against lone actor extremism. The potential impact of post-event communication on the radicalisation of other potential extremists also needs to be considered. This paper presents preliminary findings from the Communication Measures Requirements work package of the European Commission FP7 funded ‘PReventing, Interdicting and Mitigating Extreme Events: Defending against lone actor extremism’ (PRIME) project. This programme of work encompasses all activities involved in the formulation of requirements for communication measures aimed at preventing, interdicting or mitigating lone actor extremist events. Specifically, the effectiveness of existing communication measures intended to defend against lone-actor extremist events will be evaluated and semi-structured interviews and surveys will be used to identify communication measures requirements. These research findings will enhance the efficacy of risk communication about the radicalisation and violent activities of lone extremists. This approach acknowledges that public and private stakeholder behaviour in response to low-probability events often reflects the quality and availability of the information available to them.

P.44 PEIGNIER , I*; DE MARCELLIS-WARIN, N; CIRANO and Ecole Polytechnique de Montréal ; ingrid.peignier@cirano.qc.ca

Indirect cost of damages to underground Infrastructures due to excavation

Underground lies a vast network of conduits and cables that delivers products and services to today’s society. These underground infrastructures include telecommunication and electrical cables, gas conduits, sewers, water lines, drainage systems, oil pipelines, etc. The increasing number of networks, along with their shallow burial, translates into contractors regularly striking them while doing repair or rehabilitation work of all kinds. The research’s general objective is to present a detailed study of damage related indirect costs to underground infrastructures that could be used for damage prevention and as an incentive for best practices. By providing a complete list of socio-economic costs and a realistic damage related costing, this essential step will help convince contractors of the importance of damage prevention as well as help reduce the total damage related costs for everyone (companies, population, municipalities, emergency services). This project is even more relevant since urban networks are more and more buried, be it for aesthetic reasons (effort to repossess the landscape) or for security reasons (risk reduction due to climate incidents, risk elimination associated to the presence of vegetation in urban environments). In this respect, the importance of improving underground network management takes on an even greater dimension. To illustrate these evaluation methods regarding the proposed costs and to evaluate the ratio of indirect to direct costs, 4 case studies were used. These case studies are meant to represent damages to underground infrastructures in Québec. They have been chosen to illustrate different types of infrastructures that can be damaged (telecommunications, gas and water), their size as well as different cost elements that were presented in the literature review. The case studies serve to highlight the importance of damage related indirect costs, which often, indirect costs represent 80% or more of total costs, which is 4 times more than direct costs.
The Use of a Structured Design Approach for Risk Assessment in the Regulatory Context - the Example of EPA’s National-Scale Hg Risk Assessment for Electric Generating Units

The National Academy of Sciences (NAS) in their 2009 report Science and Decisions: Advancing Risk Assessment made a number of recommendations to the EPA regarding risk assessment and the risk management process. In particular, they called for more attention to be given in the formative stages of the risk assessment process, including planning, scoping and problem formulation to insure that the risk assessment addresses the specific risk management questions associated with regulatory decision making. This presentation describes a structured design approach for guiding the development of human health risk assessments used in supporting regulatory decision making. This approach links the design of a risk assessment to policy-related questions associated with a particular regulatory decision, thereby enhancing the utility of the risk assessment in informing decision making. We illustrate application of the structured design approach using the U.S. Environmental Protection Agency’s (EPA’s) recently finalized regulation addressing emissions of mercury from coal- and oil-fired power plants (the Mercury and Air Toxics Standards), highlighting the potential advantages of using the structured design approach.

Methodological Foundations for Integrating Socio-Technical Risk Analysis with Big Data Analytics

Catastrophic accidents have highlighted critical contributions of organizational factors; thus, the ability to detect and quantify organizational deficiencies is crucial in preventing accidents and maintaining safety. For historical predictions in this line of research are; what organizational factors affect risk? how do these factors influence risk? and how much do they contribute to risk? Current socio-technical risk models do not include a complete range of organizational factors. This research investigates organizational root causes of failure and their paths of influence on technical system performance, resulting in the incorporation of underlying organizational failure mechanisms into Probabilistic Risk Assessment (PRA). The field of PRA has progressed the quantification of equipment failure and human error; however, the quantification of organizational contributors lacks sources of data beyond safety climate surveys. Organizations produce, process and store a big volume of wide-ranging, unstructured data as a result of business activities and compliance requirements (e.g., corrective action program). This research develops new predictive causal modeling technologies for PRA, expanding the classic approach of data management for risk analysis by utilizing techniques such as text mining, data mining and data analytics. The research is based on a socio-technical risk theory to prevent misleading results from solely data-informed approaches. As the first study on the integration of big data with PRA, this research advances quantification of dynamic effects of organizational factors on system risk (e.g: nuclear power plant risk). It provides regulatory and industry decision-makers with important organizational factors that contribute to risk, leading to optimized decision making. Other applications include real-time monitoring of organizational safety indicators, efficient safety auditing, in-depth root cause analysis, and risk-informed emergency planning.

Quantifying Uncertainty in Radiation Dose Conversion Factors for Probabilistic Performance Assessments

Radioactive waste disposal performance assessments (PAs) are complex models employed to determine the suitability of different disposal sites and engineering designs, with particular emphasis on radiological risk. PAs involve dynamic prediction of radionuclide release, environmental transport, and human exposure and radiation dose. Although PAs are typically probabilistic, deterministic values have always been employed for the dose conversion factors (DCFs), which convert radiation exposures to a tissue-weighted effective dose. However, failure to incorporate sources of uncertainty in DCFs in probabilistic PAs results in underestimation of total uncertainty and biased sensitivity analysis. Major sources of uncertainty associated with DCFs include: 1) the biokinetic models of the dynamic distribution of radionuclides within the body; 2) the dimensions, masses, and geometric relationships of an external radiation source and target tissues; 3) the radiosensitivity of different tissues to the carcinogenic effects of ionizing radiation; and, 4) the relative effectiveness of different radiation types in causing cancer. Although effective dose is not explicitly a measure of a health effect, the reason for weighting of different types of radiation and affected organs or tissues is to address the effectiveness of the radiation exposure for inducing cancer. We present an application of uncertainty analysis in one component of DCFs (the radiation effectiveness factor; the final source of uncertainty noted above) that has been employed in a probabilistic PA. We then present a path forward to evaluate the other major sources of radiation dose uncertainty into future PAs. Finally, we describe the benefits of using cancer risk as a performance metric for uncertainty analysis, rather than the proxy of effective dose, and outline a framework for incorporating uncertainties associated with cancer dose-response into probabilistic PAs.
Recreating a historical product and designing testing methods to characterize exposures retrospectively

Retrospective exposure assessment can be challenging in the absence of historical data and unavailability of the historical product for modern-day assessment. One approach to resolve such an issue is involving product reformulation to produce historically accurate formulations and techniques. Accurate reproduction of vintage products allows for the application of modern exposure assessment techniques to evaluate exposures during product use according to anecdotal means. An example of this process will be presented in the context of asbestos-containing caulk and glazing products used historically by trades and household users. A study was designed based upon historic formula-card and mixing instructions for 3 caulk and glazing materials produced in the 1960's: 10% asbestos butyl-rubber caulk, 3% asbestos organic caulk, and 2% asbestos window glazing. Information on work task frequency, practices, tool use, aggressive finishing techniques, and clean-up activities were incorporated as a basis for simulated work activities. Work tasks included the application, finishing, and removal of caulk to shower stalls and counter tops and glazing to window frames. Replicate scenarios for product application and finishing were conducted at four curing intervals (2-hr, 4-hr, 48-hr, 2-week) followed by removal at 6 months. Observation of anecdotal work practices validated assumptions as to the negative impact on product aesthetics and function when subjected to aggressive finishing techniques. Regardless of product user skill level, cure time, or finishing technique, all exposure assessments yielded results significantly less than the current 8hrTWA PEL of 0.1 f/cc and EL of 1.0 f/cc for total fibers (PCM) and below limits of quantitation for asbestos fibers (PCME). Product reformulation coupled with exposure reconstruction serves as a valuable tool for generating empirical data which fills data gaps surrounding modern questions of potential exposure to historical products.

Microbial risk assessment needs specific exposure factors

Effective risk and crisis communication is essential for responding to threats perceived by the public through the media. The paper presents the development and implementation of the Professionalization of Risk and Crisis Communication: Training, Skills, and Outcomes course. The course is designed to fill identified gaps and provide professionals with an empirically based continuing education course. The course addresses the content of the training, including instruction on audience analysis/engagement and media relations. The results of an assessment of the program pilot are detailed including evaluation methods and outcomes. Contextualizing the current state of risk and crisis communication training, we also discuss the field’s state of professionalization and the final results of our project. TRACC received accreditation from the Federal Emergency Management Agency's National Training and Education Division and is now available to responders acting in local, state, and federal capacities.

Ensuring adequate iodine intake is considered the most direct approach to iodine deficiency prevention. Pregnancy is especially for women of reproductive age. Recent biologically based dose-response modeling of the relationships among iodide status, perchlorate dose, and thyroid hormone production in pregnant women and the fetus shows that iodide intake has a profound effect on the likelihood that exposure to goitrogenic chemicals will produce hypothyroxinemia. We evaluated the biological basis for the possibility of increasing iodine intake (e.g., through drinking-water iodization) to offset potential risks from perchlorate exposure. It is worth noting that the US FDA mandates infant formula iodine concentrations adequate to prevent iodine deficiency and, historically, iodine addition to drinking-water supplies has been successfully used to alleviate iodine deficiency in communities in Malaysia, Italy, and the Central African Republic. We also explored the potential impact of dietary exposures to nitrate on iodine uptake and thyroid hormone production. Our modeling indicates that the level of thyroid hormone perturbation at current regulatory perchlorate exposure limits is extremely small and would be completely overwhelmed by other goitrogen exposure. Our research also shows that nitrate levels in-training produce. Our analysis also shows that a very modest level of iodine supplementation, on the order of several micrograms per day, would be sufficient to compensate for and prevent the goitrogenic effects of perchlorate in drinking water. Not only would this approach address iodine insufficiency in the US among pregnant women, children, and others, it would mitigate the presence of drinking-water perchlorate while costing municipalities one tenth of the cost of the alternative method of removing perchlorate. The potential human health risks from supplementing drinking water with iodine are negligible; therefore this approach is worthy of regulatory consideration.

Risk management decisions with respect to the cancer endpoint in human populations have generally been made with respect to a 10-4 to 10-6 acceptable cancer risk range. In contrast, the quantification of non-cancer hazard (i.e., HQ, for a specific chemical and route of exposure) has generally not incorporated the concept of a range, but rather has relied upon a “bright line” for determining acceptable human exposures. Therefore, a methodology has been developed to define a “hazard range” that reflects the implicit precision of the toxicity criteria for the various non-cancer endpoints (i.e., RIC and the RfD for the inhalation exposure and oral intake, respectively, of a particular chemical), thereby enabling risk managers to more effectively balance acceptable exposures with other considerations. Hazard ranges based on the RfC or RfD from IRIS database (as defined by floor, midpoint and ceiling values) were identified for 4 chemicals, trichloroethylene, arsenic, tetrachloroethylene, and chromium (VI), predicated on an evaluation of the critical studies and endpoints used by EPA in the derivation of the RIC and the RfDs. The floor is defined as the RfC/RfD on IRIS. The ceiling is defined as the highest value of the floor (i.e., the point of departure) adjusted for the variability between the test organism and the human population, and other uncertainties (if needed). A midpoint, even though higher than the RfC/RfD, is a value within the hazard range that is unlikely to be associated with adverse effects in a human population. The midpoint is adjudged using several criteria, including the magnitude of the uncertainty factors, the steepness of the hazard slope, the confidence in the critical effect and the confidence in the POD. The methodology for defining an acceptable hazard range for a chemical may be applied, as appropriate, to the RfC, RfD or other non-cancer values derived for other chemicals and routes of exposure.

REJECT.0 Pieters, SAA*; van het Erve, AM; Vergeer, F; Van Achte, T; Marynissen, HMF; CIP Institute; stijn@pm.be
Effectice crisis response strategies based on information analysis - The Crisis Communication Work Process

The authors recently developed a “Crisis Communication Work Process” for the management and training of crisis communication teams. The result was an innovative but practical framework based on the basis of the three crisis communication methodologies and principles, such as the “Three phase consultation” model, the “Meeting clock” and the “Collaboration model”, each covering important aspects of the main working process. Over the last years, the authors have been implementing this framework for various private organisations and governmental bodies. At the end of 2013 they implemented the framework for the Belgian Federal Crisis Centre. Based on legal requirements, empirical research and practical insights, this implementation describes Belgian governments’ approach to crisis communication during a large-scale disaster since January 2014. In the near future, numerous Belgian officials will use this framework in their training and actual crisis response. Moreover, the framework has been successfully applied during various crisis situations, ranging from physical incidents such as floods, major pile-ups, hospital errors and terror threats to non-physical incidents such as fraud, cybercrime and strikes.

REJECT.0 Pieters, SAA; van het Erve, AM*; Vergeer, F; Van Achte, T; Marynissen, HMF; CIP Institute; stijn@pm.be
The Task and Tools of the Information Analyst

When a crisis occurs, a tremendous amount of data can be found on the Internet, via traditional media, and via additional sources such as incoming phone calls or a company’s Facebook page, just to mention a few. Unprocessed, this data merely resembles cluttered and invaluable rumours for a decision maker. In the crisis communication work process, there must be a role designated for processing this data. The purpose of this role is to ultimately present grounded strategic advice based on the rational, behavioural and sentimental content of the collected data. Additionally, the data analyst should be able to give continuous updates on these matters. The methodology proposed in this presentation helps to analyse a vast amount of data in a continuous cycle and to separate substantial issues from rumours. This prioritisation is critical as the amount of active Internet users during a crisis situation is increasing, hence, the number of people using online platforms to inform, consult, and express sentiment is growing as well. Therefore, automated tools are required to fulfil the data analysts’ work at hand. In this presentation, Tim Van Achte will discuss the well-defined tasks and tools for real-time data analysis during crisis situations. He will highlight the pitfalls and provide new insights on performing effective data analysis during crisis situations. Tim Van Achte presents the audience the practice behind the theory based on practical examples.
**REJECT.0** Pieters, SAA; van het Erve, AM; Vergeer, F; Van Achte, T; Marynissen, HMF; CIP Institute; stijn@pm.be

**The Link Between Analysis and Decision Making**

A rigid perception analysis is not enough to decide on a communication response. Therefore, a crisis communication team needs an advisor who resides with and consults the decision makers. This vital role provides the link between the perception and the reality, between the internal crisis management organisation and the outside world. The communication response has to be based upon clear communication objectives to gain and maintain the public trust during the entire crisis. The operational crisis management team, however, has a different goal: they have to handle the crisis effectively to return to daily business as soon as possible. Because the operational crisis management team does not focus on the public perception, it is vital for the communication advisor to serve as a liaison between them and the communication team, understanding the available options to address the crisis situation and the decisions that the crisis management team will make to achieve their goal. This offers the communication team a view on the reality of crisis management. A clear view on both the perception and the reality will provide the basis for a sound crisis communication response strategy. In other words, the communication advisor acts similarly to the operational experts in the crisis management team. He or she gathers information (offered by data analysis), constructs the image of the crisis (i.e. the public perception), provides options to shift the public perception towards the reality, advises the communication response, and delegates the operationalisation of the communication strategy. This principle is similar to how fire fighters, law enforcement officers, and medical services are working during a crisis situation. This presentation will focus on the role of the communication advisor in a well-defined working process for effective crisis communication response. A real life case will illustrate the theory in practise.

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**Scientific Challenges for the Information Analyst in a Crisis Communication Team**

Bridging the gap between perception and reality is a key challenge for every crisis communication practitioner. This presentation presents a data analysis framework, and its theoretical implementation for closing this gap. Over the last decades, various scholars have indicated how people exchange dates from the pre-social media era. Therefore, it could be argued that the tools and methodologies that have been used in the aforementioned research became out-dated. In an attempt to offer a framework for data analysis in crisis situations, in-depth grounded research has been done in numerous organisations and real life crisis situations. Underpinned by theoretical and empirical evidence, the framework for data analysis in crisis situations indicates a valuable impact on the crisis communication strategy. This presentation highlights both empirical support and challenges for practitioners and scholars in the field of crisis communication. It explores, improves, and elaborates the practice of data analysis as the basis for effective crisis response strategies.

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P.161 Pingping, Z; Zhaoqing, L; Lei, Z; Aidong, L; Yan, S; Ling, Y; Ning, L; China National Center for Food Safety Risk Assessment; zhoupingping@cfsa.net.cn

**Methodology and application for health risk classification of chemicals in foods**

Objective A method for health risk classification of chemicals in foods undertaken in China National Centre for Food Safety Risk Assessment (CFSA) is described. The aim is to accurately identify the magnitude of health risks and provide scientific evidence for implementation of risk management in food safety. Methods The method is based on the risk matrix model. Grounding of the model, based on severity and likelihood scoring is predicated on relevant reports in the literature, given risk assessment cases and expert opinion. Results The chemicals health risk classification of the risk matrix framework and its indicators system are built. The severity scores are measured using toxicity of adverse effects of a given chemical including acute toxicity and long-term toxicity should be considered jointly. The Overall Scores of indicator of severity, which are given on a scale from 1-5, correspond to the severity of insignificant, minor, moderate, major and severe, respectively. The likelihood could be estimated using exposure indicators including weighted ratio of average exposure to health-based guidance value (HBGV) and weighted percentage of populations with individual exposure levels exceeding HBGV. The Overall Scores of indicator of likelihood are also classified into 5 categories, which are given on a scale from 1-5, correspond to rare, unlikely, possible, likely and almost certain. A final risk value is presented in risk matrix, expressed as scores, combining the severity score and the likelihood score. The risk score identifies the intersection of severity and likelihood in risk matrix represents its health risk level: low, medium, high. Application of the method in an actual case has provided useful insights. Conclusion The method is simple and can be used for assessors to quickly describe the size of health risks of a chemical on a uniform scale.

M3-G.1 Pinkerton, KE*; Carosino, CM; Plummer, LE; Madl, AK; University of California, Davis; kepinkerton@ucdavis.edu

**Nanoparticles, Respiratory-Based Injury and the Role of Oxidant Stress**

The emergence of engineered nanoscale materials has provided significant advancements in electronic, biomedical, and material science applications. Both engineered nanoparticles and nanoparticles derived from combustion or incidental processes exhibit a range of physical and chemical properties, which have been shown to induce inflammation and oxidative stress in biologic systems. Oxidative stress reflects the imbalance between the generation of reaction oxygen species (ROS) and the biochemical mechanisms to detoxify and repair resulting damage of reactive intermediates. This presentation will review current research in incidental and engineered nanoparticles and their health effects on the lungs and mechanisms by which oxidative stress via physicochemical characteristics influence toxicity or biocompatibility. Although oxidative stress has generally been thought of as an adverse biological outcome, discussion will also briefly reflect on potential emerging technologies to use nanoparticle-induced oxidative stress to treat disease in a site-specific fashion.
Pharmacokinetics and excretion balance of morpholine and nitrite in rats

According to IARC, morpholine is not classifiable as to its carcinogenicity in humans (group 3). It can however undergo nitrosation during the distillation process in glassware, and is a weak carcinogen in the human organism in the presence of nitrates. The resulting metabolite, N-nitrosomorpholine, is classified as possibly carcinogenic in humans (2B) by IARC. The process of production energy can cause effluent containing morpholine to be discharged into the environment via nearby waterways. The conversion rate used to assess the health risk associated with the transformation of morpholine (MOR) into N-nitrosomorpholine (NMO) in the human body comes from the only available study, conducted in Ficher male rats by Hecht et al. 1984. Their study developed a calculation method that made it possible to estimate a maximum conversion rate of 12% for MOR to NMO. Our objective is to improve the robustness of this important parameter in health risk assessment. This toxicokinetic study was performed in six groups of male Sprague Dawley rats: three groups of three animals each for the radioactivity excretion assessment and three groups of nine animals for the toxicokinetics. Doses were 19.2 µmol MOR and 96 µmol/kg Ni for group 1, 19.2 µmol MOR and 4 µmol/kg Ni for group 2, and 0.48 µmol MOR and 4 µmol/kg Ni for group 2. Some of these doses were used by Hecht et al, while others are consistent with environmental concentrations. Our results are consistent with those of Hecht. The maximum rate found in this study was 13.3% ± 1.2, even though we used 2.5% of the concentration of morpholine and 4% the concentration of nitrates used by Hecht. Moreover they clearly showed a variation in the conversion rate with the nitrite dose for the same dose of morpholine. It was nonetheless impossible to establish from these two studies a relation that allows us to predict the conversion rate in rats from the morpholine and nitrite doses and their ratios.

Improving risk prediction models using PGA, LASSO and SVM in prostate cancer prediction

Absolute cancer risk is the probability that an individual with given risk factors and a given age will develop cancer over a defined period of time. Examples of these risk factors include race, age, sex, family history of cancer and many other factors. Considering prostate cancer recently, some common gene variations have been linked to a higher risk of prostate cancer. This research is to show testing for the gene variants will be useful in predicting prostate cancer risk. Developing prediction models that estimate the probability of cancer presence based on individual genes data over a defined period of time will help clinicians identify individuals at higher risk of specific cancers, allowing for earlier or more frequent screening and counseling of behavioral changes to decrease risk. These types of models also will be useful for designing future chemoprevention and screening intervention trials in individuals at high risk of specific cancers in the general population. To address the issue, GSE8218 dataset from Vaccine Research Institute of San Diego, as a study on Prostate cancer gene expression profile, is considered; and as a case of big data (while there are about 22,000 genes considered as variables and 148 samples), variable selection methods such as PGA (Parallel Genetic Algorithm) and LASSO (Least Absolute Shrinkage and Selection Operator) were applied to reduce the prediction dimension and so prediction error (risk) (Considering Data Mining Processes). As an efficient prediction model, SVM (Support Vector Machine) was applied and the results based on RMSEP (Root Mean Squared Error) and MSE (Mean Squared Error) show the efficiency of SVM in predicting samples with specific genes to address for prostate cancer.

Improving risk prediction models using PGA, LASSO and SVM in prostate cancer prediction

Evaluations of L. monocytogenes dose-response relationships are crucially important for risk assessment and risk management, but are complicated by considerable variability across population subgroups and L. monocytogenes strains. Despite difficulties associated with the collection of adequate data from outbreak investigations or sporadic cases, the limited availability of L. monocytogenes data, and the inability to conduct human volunteer studies, some of the available data now allow refinements of the well-established exponential L. monocytogenes dose-response to more accurately represent extremely susceptible population subgroups and highly virulent L. monocytogenes strains. Here, a model incorporating adjustments for variability in L. monocytogenes strain virulence and host susceptibility was derived for 11 population subgroups with similar underlying comorbidities using data from multiple sources including human surveillance and food survey data. In light of the unique inherent properties of L. monocytogenes dose-response, a lognormal-Poisson dose-response model was chosen, and proved able to reconcile dose-response relationships developed based on surveillance data with outbreak data. This model was compared to a classical beta-Poisson dose-response model, which was insufficiently flexible for modeling the specific case of L. monocytogenes dose-response relationships, especially in outbreak situations. Overall, the modeling results suggest that most listeriosis cases are linked to the ingestion of food contaminated with medium to high concentrations of L. monocytogenes. While additional data are needed to refine the derived model and to better characterize and quantify the variability in L. monocytogenes strain virulence and individual host susceptibility, the framework derived presents a promising approach to more adequately characterize the risk of listeriosis in highly susceptible population subgroups.
The separation of uncertainty from variability in quantitative risk assessments is a long-standing subject of debate. Quantitative methods to evaluate those two components separately have been described at least twenty-two years ago (Frey, 1992), but the significance of this separation in the microbial food safety domain was illustrated fourteen years ago (Nauta, 2000). However, few published risk assessments in the food safety domain actually consider uncertainty and variability separately, because of theoretical as well as practical limitations. A review of the developments and limitations of the approach specific to the food safety domain will be presented during this talk. Notably, limits in the separation of variability and uncertainty in predictive modeling (e.g., growth, inactivation) and in dose-response modeling will be illustrated.

Separation of uncertainty and variability in microbial food safety risk assessment: What's new after 20 years?

The governments of Canada and the United States are collaborating in developing a quantitative assessment to estimate the risk of norovirus (NoV) illness arising from consumption of bivalve molluscan shellfish (i.e., oysters, clams, mussels). The objectives of the risk assessment are (1) to characterize the factors that can contribute to contamination of bivalve molluscan shellfish with NoV, and (2) evaluate the relative impacts of preventive practices and controls on the potential risks of human NoV illness associated with shellfish consumption. A quantitative risk assessment model has been developed to meet these objectives. We present one component of the quantitative risk assessment, a meta-analysis and inference model focused on viral loads in wastewater and discharges from wastewater treatment plants (WWTPs). WWTP effluent is a known source of NoV that can impact the sanitary quality of shellfish harvest areas. Data used in this analysis were drawn from the scientific literature and previously unpublished surveillance data from Canada and the United States. The seasonal variations of wastewater levels of NoV genotypes I and II and male-specific coliphage (MSC) were characterized. Virus reduction efficacies achieved by the two common WWTP designs were determined separately for NoV genotypes I, II, and MSC. The impact of disinfection on viral loads in WWTP discharges was also quantified. For a given type of WWTP, mean reductions of NoV (log10 genome copies/L) and MSC (log10 plaque forming units/L) were correlated. Given that NoV is not culturable, the use of MSC as a process indicator to determine the virus reduction efficiency of WWTPs is supported.

Risk Assessment on Norovirus in Bivalve Molluscan Shellfish

Characterizing variability and uncertainty is central to food safety risk assessment. However, there are limitations to the ability to empirically separate variability and uncertainty. A simple regression analysis is used to illustrate. Consider two models based on the same hypothetical experimental data. Model 1 has one explanatory variable and accounts for 80% of the observed variance. Model 2 has two explanatory variables and accounts for 90% of the variance. In many risk assessment applications, there may be practical reasons for using the more parsimonious model (e.g., observational data are unavailable for the second experimental control variable). A portion of the residual variability unaccounted for by Model 1, however, becomes parameter uncertainty under Model 2. When analyzed separating uncertainty and variability, the two models agree with respect to the central tendency of the output but result in ambiguity about the percentiles of the variability distribution and attendant uncertainty. Consequently, separating variability and uncertainty is model-dependent and somewhat arbitrary.

Considering variability and uncertainty in food safety risk assessment

Three-class sampling plans based on marginal and unacceptable microbial limits have been used for food safety lot acceptance sampling and have been recommended for process control purposes. However, existing microbiological criteria based on three-class samplings do not consider variability, resulting in highly inconsistent false-alarm rates for detecting out-of-control processes for processes with substantially different common cause variation. The formal design approach for three-class sampling plans recommended by the International Commission on Microbiological Specifications for Foods (ICMSF) is intended for lot acceptance sampling and is inappropriate for process control because it would result in false-alarm rates greater than 50%. A more general approach to the statistical design of three-class sampling plans is presented that takes variability into account and makes the plans suitable for process control purposes. However, if the limits are set based on microbiological considerations (e.g., shelf-life, hazardous levels) rather than statistical design specifications, then the three-class sampling plans may continue to serve a useful food safety function by indicating marginal and unacceptable microbiological quality. However, this function is distinct from that of sampling plans with limits derived from observing a process under control where exceedances of the limits indicate a potential loss of statistical control.

Considering the Design of Three-Class Sampling Plans for Process Control

Shellfish Risk Assessment on Norovirus in Bivalve Molluscan Shellfish
Factors such as environmental exposures, nutrition, genetic polymorphisms, and life stage are receiving increased attention for their ability to introduce variability into the potential risk associated with a chemical or group of chemicals. Yet, these factors may include disparate datasets that are difficult to compare; thus, integrating them into a risk assessment is challenging. Adverse Outcome Pathways (AOPs) are recognized as a useful tool to organize data through a series of biological responses leading to an adverse response. Building on the existing AOP framework, this presentation integrates factors that may modulate potential human health effects of inorganic arsenic (iAs) exposure. iAs is associated with a number of human health effects including cancers of the skin, lung and bladder. We used iAs-induced bladder cancer as an example to evaluate the utility of an AOP framework for integrating factors that may modulate potential risk. A literature review was conducted to identify the factors that may increase risk for transitional cell tumors (urothelial carcinomas) of the urinary bladder. Using an AOP framework, we organized scientific information to facilitate a qualitative evaluation of how individual-level factors and life stage may impact the risk of bladder cancer. Initial results indicated that factors associated with reduced secondary methylation of iAs (e.g., gender, nutrition, genetic polymorphisms), as well as other factors like smoking may correlate with increased risk of bladder cancer. Next, we developed a series of concordance tables to qualitatively evaluate the strengths and weaknesses of data associated with each factor in modulating the AOP. Our results demonstrate the utility of an AOP approach for considering factors that may modulate potential health risks of environmental chemicals, such as iAs. Disclaimer: The views expressed are those of the authors and do not necessarily represent the views or policies of the US EPA.

The determination of potential future risks to the Department of Defense from emerging contaminants is a complex process that lends itself to the use of expert elicitation. Expert elicitation is a process by which the judgment of subject matter experts (SMEs) is used to quantify some uncertain quantity, relationship, parameter, or event. To assist in the identification of future risks, the Department uses multiple subject matter experts to help quantify the likelihood and the severity of potential impacts. Subject matter experts are sought from both inside and outside of the Department on five distinct areas of the Department’s operations: 1) Environmental Safety and Health, 2) Readiness and Training, 3) Operation and Maintenance, 4) Early Acquisitions Research and Development; and 5) Site Investigation and Clean up. The input of the subject matter experts is used to quantify not only the likelihood and severity of the potential events but also to capture the SMEs’ confidence in those estimates. Analytical tools are used to explore the impact of confidence predictions on the SME individual and group risk estimates. This presentation will provide an overview of the elicitation process and the results of several elicitation sessions with subject matter experts for a range of emerging contaminants from the past 5 years.
Computational Fluid Dynamic (CFD) Modeling as a Tool in Retrospective Exposure Assessment: Application, Value, Validation, and Limitations

Computational Fluid Dynamic Modeling (CFD) has been utilized in a host of applications including design of the space shuttle, determination of aircraft lift, and optimization of automobile design. CFD also provides the exposure assessment scientist a tool with which to perform detailed fate and transport modeling of air contaminants without necessarily performing air sampling. Laboratory and outdoor tracer gas studies have been completed to compare air concentration measurements with modeled results. Unique design solutions have been developed to evaluate occupational exposures, especially to perform retrospective exposure assessment evaluations. This presentation will also explore the sensitivity of ventilation, air current, source geometry and placement, and breathing zone assumptions on the application of this method. Application examples will be demonstrated and discussed.

Application of a Multiplicative Model for Assessment of Lung Cancer Risks Associated With Asbestos Exposure and Smoking: Resolving Relative Risk Confusion

The interaction between asbestos and smoking in estimating lung cancer risk has been intensively discussed in the literature, starting with the classical work of Hammond and Selikoff. However, there is still confusion about the character of this interaction. For example, application of multiplicative model for relative risks for asbestos and smoking may express not an effect modification, but rather an independence of the factors. There are also studies that suggest that relative risks associated with asbestos exposure may be lower for smokers than for non-smokers, but on an absolute risk basis, the increase in lung cancer risk is lower for non-smokers than for smokers. Consideration of this apparently confusing statement leads to a better understanding of actual risks for smokers and non-smokers. Clarification of lung cancer relative risk determinations relative to asbestos and cigarette smoking, which allows comparison of the relative contributions of both exposures to the development of the disease, will be presented.

Review of Epidemiological Studies of Lung Cancer Risk from Cigarette Smoking: Sorting Out the Important Determinants

The literature regarding the association between smoking and lung cancer is abundant. At this stage, it is important to outline a roadmap for a combined protocol to evaluate relative risks of lung cancer based on specific behavioral patterns. The presentation will explore important determinants of lung cancer risks and discuss uncertainties and limitations of relative risk quantification. It will be demonstrated how Monte-Carlo simulation can help in evaluation of the risks in a retrospective assessment for a cigarette smoker.

Flexible design to increase resilience to natural disasters

Risk and resilience have been the subject of recent scientific interest in the context of infrastructure development for natural disasters. While risk assessment requires explicit definitions of threat, vulnerability, and consequence, resilience as defined in the engineering, ecological, and environmental fields refers to the ability of a system to absorb and recover from a severe disturbance or extreme event. We envision resilience as a system property that requires integration of physical, social, and information domains, whereas risk may only be assessed in a single domain. Engineered physical protection against a disaster is one area where risk and resilience can be integrated to develop a resilient engineered and community system; however, currently these interactions between the physical and social systems are not well understood or modeled. This work investigates the potential benefits of flexible design in engineered protection by contributing to community resilience and reducing risk of infrastructure failure. This project evaluates how the social domain can inform the design of the physical system and compare changes in risk and resilience to a natural hazard. We apply this method to the case of coastal flood protection in Jamaica Bay, New York, an area severely impacted by Hurricane Sandy, and a site selected for city investment of $15 million dollars toward disaster resilience and risk mitigation strategies. Interviews with experts and residents provided responses for the social resilience metrics and were used to derive options for flexible design of infrastructure. Results quantify the impact of implementing a range of flexible design options on risk reduction, vulnerability, and resilience of the system. With this information, the city and community can make decisions for allocating funds and resources that align with their own values and thresholds of risk tolerance.
All-hazard approaches to infrastructure risk reduction: Effective investments through pluralism

Infrastructure networks must balance strategic investments among defense against terrorism, natural disasters, accidents, substitutionary networks, climate change, and system age. Each possesses unique threat characteristics, yet potentially overlapping defensive strategies. To date, little research has been conducted to understand these defensive strategies and how to balance their tradeoffs. There is scant understanding on which models prove valuable when or how to integrate models to provide a more all-hazard perspective. In this research, we develop a pluralistic framework for understanding and ultimately modeling strategic, long-term infrastructure investments. We highlight the inherent dichotomy between an operator and society’s perspective, between mitigation and response strategies, and among varying temporal perspectives and risk tolerances. We then conclude with opportunities for future research. We highlight the framework in context of a natural gas distribution system. Large investments are expected in the natural gas distribution system in the upcoming decades. Mid-Atlantic cities tend to have 30-50% of their distribution pipelines made of fragile cast iron and natural hazards can produce natural gas fires that burn for days. Saboteurs have multiple options in disrupting the system and natural gas is seen by some as a transitional fuel to ultimately be phased out despite its current demand and affordability.

Validation of a pesticide dietary exposure model with biomonitoring data - case study for chlorpyrifos

Chlorpyrifos is one of the most commonly used insecticides in the United States. As part of its risk assessment process for registration review, the U.S. Environmental Protection Agency (EPA) has performed a dietary risk assessment that estimates population exposures from food and drinking water. The estimates from food are derived from a model that incorporates population data on food consumption and residue data on chlorpyrifos residues on food. The drinking water estimates are derived from a modeling simulation for a reservoir in an area with high chlorpyrifos use. The food and drinking water estimates can be compared with estimates of exposure from biomonitoring data. In 1999-2002, a chlorpyrifos metabolite, 3,5,6-trichloro-2-pyridinol (TCPy), was included in the National Health and Nutrition Examination Survey (NHANES). More than 4,000 TCPy urine samples were included in NHANES. Chlorpyrifos exposures were estimated from the TCPy data and the estimates were compared with EPA’s food and drinking water estimates. There was excellent agreement between the TCPy estimates and the EPA modeling estimates for food, but when drinking water was included, the EPA theoretical dietary exposure estimates substantially exceeded the estimates from actual TCPy values. The likely reason is the very conservative nature of EPA’s drinking water modeling estimates. There is also an extensive water monitoring database for chlorpyrifos, with greater than 30,000 samples over the last two decades. When using exposure estimates derived from the water monitoring data instead of the EPA modeling estimates, excellent agreement with the TCPy-derived exposure estimates were obtained.
Reflections on black swans and emerging risks

The paper will address different types of black swans: (1) the tail ends of a normal distribution (low probability or dependent probabilities); (2) events linked to problems in knowledge and lack of transfer of knowledge (asymmetry of knowledge distribution) and (3) unique events for which there is no historical record for a re-occurring patterns. These three types of black swans demand different and tailored methods of assessment and management. Tail ends phenomena need better assessment methods to characterize and evaluate rare events beyond the two or three standard deviation integral. Asymmetry of knowledge demands better methods to monitor knowledge, access new sources of knowledge and decrease communication hierarchies. Finally, unique events cannot be calculated or assessed but systems may vary to the probability that they can get under stress from unique events. Geological formations may not be very vulnerable, stock markets are probably highly vulnerable. The more vulnerable a system is the more important are management preparations to increase resilience. Vulnerable systems need to be enhanced so that they can sustain their functionality even when they are stressed by unknown events. However, this requires a delicate balance between resilience and efficiency. Highly efficient systems are usually not resilient. On order to make appropriate decisions there is a need for broad value judgments where due weight is given to the uncertainties.

Assessment of Commercial Fishing Risk with Respect to Extratropical Cyclones in Atlantic Canada

Commercial fishing is one of the most dangerous occupations in Canada. In addition to the relatively high probability of perishing, fish harvesters are also at risk of suffering a wide range of non-fatal injuries during their work at sea. Weather factors are an intrinsic part of fish harvesters' operating environment and they consider the most dangerous situations at sea to be associated with weather-related factors. Mariners in Atlantic Canada may experience different types of severe weather, particularly extratropically transitioning cyclones sweeping over the Atlantic basin. This research aims to answer questions regarding the effects of cyclone weather conditions on maritime fishing traffic and incidents. Three major types of data (i.e. weather, marine incidents and traffic) will be matched spatially and temporally and modelled to achieve a general understanding of their relationships. The potential cyclone weather factors are wind speed, air and sea surface temperature, Laplacian pressure, specific humidity, precipitation, and ice coverage. Statistical and Geostatistical methods such as logistic regressions, classification and regression trees, neural networks and geographically weighted regression are applied to recognize patterns in incident occurrence, incident severity levels, and relative incident rate with respect to different weather conditions. The related project goal is to predict future risk levels based on potential climate change scenarios. Studies suggest that Canada will warm more than the global average and this phenomenon will influence the intensity and frequency of extreme events. Since there are different scenarios about how climate change will effect cyclones in Canada, once the statistical relationships between weather factors and fishing safety have been established, various regional Climate Change predictive models will be applied to anticipate the impacts on future fishing risks arising from potential weather changes.

Modeling of Chlorine Inactivation in Municipal Water Contaminations

Residual chlorine present in municipal water systems prevents potential growth and spread of microorganisms introduced into the system. Estimating the extent of inactivation following contact is often required to consider the organism's sensitivity to chlorine and the potential for other material introduced with the microorganism to also consume residual chlorine. A variety of chlorine inactivation models have been proposed and explored in the literature. Often these methods rely on a steady-state assumption for chlorine concentration allowing a pseudo-first order kinetic model to be used (Chick's law for example). However, it is possible for enough material to be introduced that the steady-state assumption for chlorine concentration would be invalid. To adequately model the impact of chlorine on organism viability in these situations, we have reverted to the fundamental kinetic equations (a couple set of ordinary differential equations) and implemented a novel approach for addressing the stoichiometry of the chlorine microorganism reaction by adopting a kinetic modeling approach often used in the analysis of heterogeneous catalysis reaction kinetics. We will present the approach used and illustrate the ability of the approach to successfully capture inactivation kinetic data reported in the open literature.
W2-J.2 Rickard, LN*; Esco, GM; Scherer, CW; SUNY College of Environmental Science and Forestry and Cornell University; rickard@esf.edu
Do I stay or do I go? Exploring predictors of behavioral decision-making during Hurricane Sandy
For those living on the coast, storm surge is the most potentially deadly risk. During Hurricane Sandy, in October 2012, 40 deaths were directly attributed to flooding that occurred due to a dramatic slow rise of ocean surge. While scientists and coastal managers continue to characterize “objective” storm surge risk, less is known about how coastal residents perceive such risks, and how these perceptions—in addition to other factors—may influence behavioral decision-making. Within the natural hazards literature, researchers have proposed comprehensive models to predict preventive action and decision-making during severe weather events, integrating social psychological concepts such as efficacy, with sociological concepts, such as institutional trust. Risk communication researchers have forwarded models to predict information seeking and processing with respect to risk issues, introducing concepts such as information sufficiency and informational subjective norms. Drawing upon two models that exemplify these approaches, the Protective Action Decision Model (Lindell & Perry, 2012) and the Risk Information Seeking & Processing Model (Griffin, Dunwoody, & Yang, 2012), the present study proposes an expanded model to understand communication and decision-making during a hurricane. Using a random sample of residents of New Jersey, New York, and Connecticut affected by Hurricane Sandy, we employ a web-based survey to explore, among other variables: (a) perceptions of hurricane and storm surge risk; (b) trusted information sources; (c) preferred communication channels; (d) strength of social networks; (e) previous hurricane experience; and (f) attribution of responsibility for preventing and responding to hurricanes. By asking about survey respondents’ (non)evacuation and information-seeking behavior during Sandy, we explore the applicability of the expanded model to a real-life case. Practical implications, such as best practices for emergency managers, are discussed.

T2-F.1 Riggs, P; Professor and Director of the Division of Substance Dependence, Department of Psychiatry, University of Colorado School of Medicine; paula.riggs@ucdenver.edu
The Effects of Marijuana on the Mental Health of Adolescents
Current research indicates that there is a significant inter-relationship between marijuana and mental health problems across the developmental spectrum. Dr. Riggs will review key studies suggesting that adolescents are more vulnerable to both addiction and mental health problems, in part due to rapid brain development that occurs throughout early adolescence into young adulthood. Dr. Riggs will also review the growing body of evidence indicating that regular cannabis use during adolescence may be associated with reductions in adult IQ and persistent neurocognitive deficits that may not be fully reversible even with prolonged abstinence. Results of longitudinal studies also suggest that prenatal exposure to marijuana may cause longer-term neurocognitive deficits that may lead to mental health, learning, and behavior problems in early to mid-adolescence. Emerging data from both animal and human studies suggesting that both pre-natal cannabis exposure and adolescent marijuana use may exert a “kindling” effect during these critical periods of rapid brain development that appear to increase vulnerability to cannabis and other substance use disorders and increased risk of persistence of addiction into adulthood. Research on the neurocognitive and mental health effects of chronic, heavy marijuana use in adult will also be reviewed. The clinical implications and public health impact of this research will be discussed.

W2-D.3 Rios Insua, D; Rios, J; Banks, DL*; Duke University; banks@stat.duke.edu
Adversarial Risk Analysis Models of Opponent Behavior
Adversarial risk analysis deals with cases in which two or more agents make decisions with random outcomes that depend on the decisions made by various agents. The analysis supports one of the decision makers who must forecast the actions of the other agents and, consequently, the random outcome that each agent will receive. This requires modeling the behavior of opponents, which entails strategic thinking. We focus on simultaneous decision-making by two agents. Our supported agent may face different kinds of opponents, who may use different rationality paradigms; e.g., the opponent may behave randomly, or seek a Nash equilibrium, or perform level-k thinking, or use mirroring or prospect theory. We describe the appropriate analysis for these situations, and also show how to model our uncertainty about the rationality paradigm used by the opponent through a Bayesian model averaging approach.

T3-D.4 Rivers, JD*; Siu, NO; Nakoski, JA; Lee, PS; Cervera, MS; Gordon, D; US Nuclear Regulatory Commission; joseph.rivers@nrc.gov
Increasing the Use of Risk-Relevant Information for Security at the Nuclear Regulatory Commission
The Nuclear Regulatory Commission (NRC) promotes the use of risk-relevant information in its regulatory process. The use of risk-relevant information is extensively in the realm of reactor safety. Risk-relevant information is used to some extent in security, but there is room for more elements of the regulatory process to take advantage of risk approaches. The NRC has conducted two risk-informing security workshops to identify possible areas for potential activities. One was hosted by Sandia National Laboratories and the other by the Institute of Nuclear Materials Management. Areas that are under consideration include, leveraging risk approaches used in the safety arena, increased use of computer modeling tools, cyber security, the likelihood of an adversary attack, and grading security requirements based on the attractiveness of nuclear materials to a potential adversary.
W4-B.5 Rizzi, L; Cifuentes, LA*; Cabrera, C; Browne, M; Iglesias, P; P Universidad Católica de Chile; lac@ing.puc.cl

Valuing mortality risk reductions from traffic accidents and air pollution abatement in Chile. Can we get an 'official' value?

Since 1974 all public infrastructure investment decisions in Chile are subject to a formal cost-benefit analysis. Costs are quantified using social prices which have historically been considered mainly travel time saved by the population. The responsibility of conducting these analyses, and proposing the methods and key parameters (such as the social discount rate) is within the Ministry of Social Development. In 1994, the General Environment Law was enacted, establishing the basic environmental management instruments (environmental quality standards, emission standards, pollution abatement plans, among others) available to the authority. The law requires that the application of any of these instruments undergo an assessment of their economic and social impacts. Though not explicitly required, many of these assessments have included a cost benefit analysis. The Ministry of Environment performs these assessments. A key element for the results of both types of analyses is the social willingness to pay for reductions of premature mortality risks arising from reduction in fatal accidents, and from ambient air pollution reduction. This presentation reports the design, application and results of a discrete choice survey to elicit WTP for reductions in mortality risks from traffic accidents and from cardiovascular disease (injection at 12 months). The survey population was defined to a representative sample of Chilean population. In pilot tests it was found that the capacity of low education segments of the population to understand the risk themselves and much less their tradeoff willingness to pay was limited, so the instrument had to be simplified. Since the study was developed under the auspice of the Ministry of the Environment in coordination with the Ministry of Social Development, it is expected that the results of the survey will help public regulators better evaluate decisions regarding infrastructure and environmental quality improvements in Chile.

M4-J.6 Rogers, MB*; Krieger, K; Jones, E; Amlot, R; King’s College London and Public Health England; brooke.rogers@kcl.ac.uk

Communicating Public Health Advice during a Chemical Attack Involving Sarin: Results from a Live Decontamination Exercise in the UK

It is a common assumption that, in the event of a chemical, biological, radiological or nuclear (CBRN) attack, a well-prepared and informed public is more likely to follow official recommendations regarding the appropriate safety measures to take. We present findings from the European Commission funded PRACTICE project. Our study investigated the ability of crisis communication to influence public perceptions of risk and behaviour during a live field exercise simulating a chemical attack involving sarin. Forty members of the public participated, alongside 100 professional volunteers and members of the emergency services. Public participants were divided into a high-information group (N=20) where they were provided with information about the event and emergency response processes, and a control group (N=20) where they received the standard information communicated by responders. Data was collected at key time-points during the emergency response (i.e. evacuation, decontamination and survivor reception centre), as well as via pre and post-event questionnaires, and during focus groups conducted at the end of the field exercise. Qualitative analysis indicates that individual risk perceptions play a limited role in shaping public responses during an evacuation and decontamination event. Instead, public perceptions of the threat, emergency responders and response procedures were shaped by social interactions and observations. Quantitative results indicate that risk communication had a significant impact on public responses during the event. Statistically significant differences were reported between participants in the high-information group and control group. High-information group participants rated the probability of risk communication provided more highly than the control group, perceived themselves as more capable of engaging in the protective behaviours required (self-efficacy), and perceived more value in the emergency response processes and procedures.

P.141 Roh, C*; Bier, V; Corradini, M; Lui, S; University of Wisconsin-Madison; cgroh@wisc.edu

Development of an Updated Societal-Risk Goal for Nuclear Power Safety

The safety-goal policy of the U.S. Nuclear Regulatory Commission (NRC) has never included a true societal-risk goal. Current safety goals focus solely on the prevention of both prompt and delayed radionuclide releases. However, the goals are normalized by population in the vicinity of the plant, so do not provide an upper bound on the total fatalities that could occur in high-population areas. Hence, we have evaluated the population relocation that could occur after severe reactor accidents as a possible basis to develop a societal-risk goal for nuclear plants. In particular, relocated population appears to be a good proxy for societal disruption, and is relatively straightforward to calculate. Our analysis considers several accident scenarios at five nuclear sites in the US. Realistic source terms and actual past weather data were used to compute offsite consequences that would have occurred in an accident that had occurred on any of several specific dates over a two-year period. The resulting plumes were compared with population data to determine the population that would have needed to be relocated in order to meet current protective-action guidelines. The thresholds for relocation were also varied, to investigate the tradeoffs involved in relocating fewer people (to reduce societal disruption), thereby increasing the expected number of latent cancer among the non-relocated population (under the linear no-threshold assumption). Safety goals' taking into account societal disruption due to relocation could in principle be applied to the current generation of nuclear plants, but could also be useful in evaluating and siting new technologies.

T4-B.4 Robinson, LA*; Hammitt, JK; Harvard University; robinson@hsph.harvard.edu

Understanding the Distribution of Regulatory Costs and Benefits: Motivation and Evidence from Case Studies

In addition to assessing the costs and benefits of major environmental, health, and safety regulations, Federal agencies are required to consider how these impacts are likely to be distributed across population subgroups. We find, however, that agencies largely ignore these requirements, paying little or no attention to who bears the costs and who receives the benefits of their regulations. Thus we are uncertain about both the magnitude of the distributional impacts and the extent to which such regulations are regressive, as posited by many observers. Agencies generally have access to data that could be used to assess how benefits are distributed. In contrast, it is generally very difficult to estimate how costs initially imposed on firms are passed on or absorbed as changes in prices, wages, and profits, and to then determine how these changes affect the disposable income of individuals belonging to different population subgroups. In this paper, we first discuss approaches for estimating the distribution of the costs and benefits of conventional environmental, health, and safety regulations. We focus on approaches that are both pragmatic, given available data, and consistent with theory. We then test these approaches by applying them to case studies of previously promulgated rules. Our findings provide insights into the importance of distributional impacts and the implications for the design of future regulations. Our increased analysis may be feasible and useful. We also demonstrate how such analysis may be best conducted, taking into account data limitations and related uncertainties.
W3-B.4 Rose, AZ; University of Southern California;
adam.rose@usc.edu
Advances in the Center for Risk and Economic Analysis of Terrorism Events (CREATE) Framework for Economic Consequence Analysis
Researchers at the Center for Risk and Economic Analysis of Terrorism Events (CREATE) have developed a comprehensive framework for Economic Consequence Analysis (ECA). The framework was first extended to include resilience, or ways to reduce business interruption losses by utilizing remaining resources more efficiently and recovering more quickly, and behavioral linkages relating to the economic costs associated with the social amplification of risk and stigma affects. The paper will summarize current research for further extensions into areas of cascading failures and spillover effects. The latter are integrated without a priori having to decide whether the events gain associated with mitigation are a cost or a benefit. The paper will also summarize current research for further extensions into areas of cascading failures and spillover effects. It will also discuss applications of the framework to enhancing DHS risk analysis models to include more features of ECA. The paper will conclude with a discussion of how the research presented in the other papers in the session can be integrated into the CREATE ECA framework.

W3-D.2 Rosen, JS*; Whelton, AJ; Corona Environmental Consulting; jrosen@coronaenv.com
Expert Evaluation of Chemical Spill of Crude MCHM into the Elk River, the West Virginia Testing Assessment Project (WV TAP)
On January 9, 2014, an undetermined amount ‘Crude MCHM’ spilled from a storage tank into the Elk River, upstream of the Kanawha Valley water treatment plant operated by West Virginia American Water (WVAW). The first signs that something was amiss came from customer complaints of a licorice odor in the air. When the spill had started or how much MCHM had made its way into the Elk River was unclear. Little was known about Crude MCHM components but critical decisions were needed on whether to stop pumping Elk River water into the treatment plant, what if any treatment should be applied, and whether the water was safe. State, federal, water industry and private sector experts were rapidly mobilized. 300,000 residents were without water for all uses other than flushing toilets for up to 9 days. After the do not use order was lifted the licorice odor persisted, leading to a reluctance by many residents to use tap water for anything other than toilet flushing. One month after the spill, most chemical analyses were reporting non-detect values significantly lower than health effects screening levels established by the Centers for Disease Control and Prevention (CDC). Research on an odor threshold for MCHM was designed and conducted by Dr. Michael McGuire, along with Dr. I. H. (Mel) Suffet. The objectives of this task were to develop a method to estimate odor thresholds and convene a panel of odor experts to estimate threshold concentrations of detection, recognition, and objection (complaint). An Odor Threshold Concentration was established at less than 0.15 ppb; odor recognition and objection concentrations were also estimated. These odor thresholds support consumer observations in Charleston, WV that people could recognize and object to the licorice odor caused by crude MCHM in their drinking water even while analytical results were below detection limits. The results from the ten-home study provided data on the variability of concentrations and conditions within homes to help design sampling for the larger community to answer the critical questions. A community-wide sampling plan was prepared so that the State of West Virginia could consider the next steps in the recovery of their drinking water infrastructure.

W3-D.3 Rosen, JS; Corona Environmental Consulting; jrosen@coronaenv.com
Establishing an Odor Detection Threshold for Crude MCHM and Design of Larger Sampling Plan
The West Virginia Testing Assessment Project (WV TAP) conducted an in-depth analysis to determine the odor threshold for MCHM and used the initial assessment of the concentration and variability of MCHM at the taps in the ten home study to design a statistically robust sampling plan for the entire affected area. One month after the do not use order was lifted for water consumers in West Virginia, the distinctive licorice odor persisted, leading to a reluctance by many residents to use tap water for anything other than toilet flushing. Most chemical analyses were reporting non-detect values for MCHM that were significantly lower than health effects screening levels established by the Centers for Disease Control and Prevention (CDC). Research on an odor threshold for MCHM was designed and conducted by Dr. Michael McGuire, along with Dr. I. H. (Mel) Suffet. The objectives of this task were to develop a method to estimate odor thresholds and convene a panel of odor experts to estimate threshold concentrations of detection, recognition, and objection (complaint). An Odor Threshold Concentration was established at less than 0.15 ppb; odor recognition and objection concentrations were also estimated. These odor thresholds support consumer observations in Charleston, WV that people could recognize and object to the licorice odor caused by crude MCHM in their drinking water even while analytical results were below detection limits. The results from the ten-home study provided data on the variability of concentrations and conditions within homes to help design sampling for the larger community to answer the critical questions. A community-wide sampling plan was prepared so that the State of West Virginia could consider the next steps in the recovery of their drinking water infrastructure.

W3-D.4 Rose, SR*; Handschy, M; Apt, J; Carnegie Mellon University; srose@cmu.edu
Is It Always Windy Somewhere? Occurrence of Low-Wind-Power Events Over Large Areas
We estimate the probability of low aggregate wind power in a large geographic region using Large Deviations Theory (LDT). Periods of low wind power in a region partly determine the capacity of conventional power plants needed as a backup for wind power. We use LDT to estimate the probability that the aggregate power of several wind farms falls below a given threshold, extrapolating beyond the limited historical data. A simple formulation of LDT assumes that the power output of each individual wind farm is an independent, identically-distributed (i.i.d.) random variable, an assumption violated by real wind farms. For weakly-correlated wind farms with similar power distributions, an equivalent i.i.d. distribution and effective number of independent farms accurately models observed behavior. For wind farms that have more correlated and less similar power distributions, we propose a generalization of LDT that does not assume i.i.d. random variables.
Modeling Values and Trade-offs of Cybersecurity Stakeholders

The U.S. benefits from the wealth of information and communications technologies available to individuals, communities, organizations/companies and the nation as a whole. However, just as such technologies provide new opportunities for advanced operations and growth, they also involve risks to privacy, data security, and financial and other assets. The cyber threat can be characterized within a risk management framework in which attackers attempt to penetrate and misuse cybersystems, defenders seek to protect cybersystems, and users of cybersystems can create vulnerabilities or support defenses. To model the interactions among these three stakeholders, it is important to understand who they are, what objectives they strive to achieve, and which strategies are commonly used to achieve these objectives. This research aims to describe the objectives and motivations that drive cyber attacker, defender and user behavior in more detail.

We develop objectives hierarchies and multi-attribute utility (MAU) models for each stakeholder in the historical context of an attack on the Sony PlayStation network (2011). For each of the three stakeholders, a model is proposed using information about motivations, objectives, and beliefs relative to the PlayStation incident. Each model represents values relevant to the multiple and conflicting objectives of each stakeholder, including attitudes toward risk, trade-offs among conflicting objectives, and uncertainty about the outcomes for particular alternative strategies. These models were initially informed by a variety of sources, including past behavior related to cyber data breaches, defender web sites, news articles, social networking sites (particularly for users) and unclassified intelligence, and later further developed based on information from actual players and/or values experts speaking to the stakeholders’ values. These models are intended to serve as a proof-of-concept demonstration of MAU modeling in the cyber domain.

The Varieties of Adaptive Management and Their Ties to Administrative Law: Experiences from the Department of the Interior

The term “adaptive management” is invoked to describe many natural resource management applications that permit some sort of feedback management behavior. However, adaptive management is a particular case, but the specific meaning of the term varies from case to case. These variations range from systems of closed-loop control to address uncertainty that has been specified a priori, to collaborative, multi-stakeholder systems designed to adapt to insights about the fundamental values being pursued, with many permutations in between. In all cases, the adaptive management process is designed to help manage risk, but the nature of the risk being managed differs among cases. For federal agencies managing resources held in trust for the public, a critical concern is the link between the adaptive management process and administrative laws, in the U.S. especially the National Environmental Policy Act, the Administrative Procedure Act, and the Federal Advisory Committee Act. Here I describe the underlying definition of adaptive management and considerations of administrative law for three applications of adaptive management by agencies within the U.S. Department of the Interior: the Adaptive Harvest Management of waterfowl hunting; the Glen Canyon Dam Adaptive Management Program; and efforts to manage the take of eagles at wind energy facilities.

Assessment of Inter-Individual Variability in Chemical Safety Testing: Replacing Defaults with Scientific Evidence

A shift in toxicity testing from traditional in vivo to higher throughput in vitro methods creates promise to prioritize compounds, uncover mechanisms of toxicity and provide rich data for predictive modeling of adverse health effects. The quantitative high-throughput screening (qHTS) paradigm, in which hundreds of compounds may be profiled rapidly in dozens of cell lines and multiple biological targets, is one of the major data streams in computational toxicology. While existing qHTS approaches have been applied to a number of human and rodent cell lines, thus allowing for species and tissue comparisons, the inter-individual genetic variability has not been considered at this scale yet. Our goal was to aid in the development of predictive in vitro genetics-anchored models of chemical toxicity by assessing inter-individual variability and heritability of toxicity phenotypes using human lymphoblast cell lines from the International HapMap and the 1000 Genomes projects. This presentation will detail the results from two large-scale collaborative projects between the University of North Carolina at Chapel Hill, the Division of the National Toxicology Program at NIEHS, and the NCATS. About 1100 lymphoblast cell lines from 9 populations representing 5 continents and multiple racial backgrounds were used in these experiments. The cytotoxicity of several hundred chemicals was evaluated in qHTS format. qHTS screening in the genetically-defined population of human cells produces robust and reproducible results, which allows for cross-compound, -assay and -individual comparisons. This in vitro screening model offers exceptional opportunities for identifying genetic modifiers of toxicity at the DNA sequence level, filling gaps in high-throughput risk assessments by establishing population-based confidence intervals in toxicity, and probing candidate susceptibility pathways by exploring the correlations with mRNA levels.
P.70 Ryti, RT*; Chang, N; Templin, H; Stubbs, C; Simmons, L; Wilson, LH; Interstate Technology and Regulatory Council (ITRC) developed the Technical and Regulatory Web-based Guidance on Groundwater Statistics and Monitoring Compliance (GSMC-1, 2013, http://www.itrcweb.org/gsmc-1/) and associated training specifically for environmental project managers who review or use statistical calculations for reports, who make recommendations or decisions based on statistics, or who need to demonstrate compliance for groundwater projects. The presentation will be an overview of the training class developed based on the GSMC-1 guidance and will encourage and support project managers and others who are not statisticians to use the ITRC Technical and Regulatory Web-based Guidance on Groundwater Statistics and Monitoring Compliance (GSMC-1, 2013) to make better decisions for projects; apply key aspects of the statistical approach to groundwater data; and answer common questions on background, compliance, trend analysis, and monitoring optimization.

W3-C.3 Saber-Freedman, N*; Schmitt, K; Francis, R; Concordia University; George Washington University; sf.noah@gmail.com

Groundwater Statistics for Environmental Project Managers

Statistical techniques may be used throughout the process of cleaning up contaminated groundwater. It is challenging for practitioners, who are not experts in statistics, to interpret, and use statistical techniques. Interstate Technology and Regulatory Council (ITRC) developed the Technical and Regulatory Web-based Guidance on Groundwater Statistics and Monitoring Compliance (GSMC-1, 2013) to make better decisions for projects; apply key aspects of the statistical approach to groundwater data; and answer common questions on background, compliance, trend analysis, and monitoring optimization.

M3-B.4 Sahlin, U*; Vareman, N; Lund University; ullrika.sahlin@cec.lu.se

Is the Weight of Evidence approach in risk assessment according to REACH an application of a general perspective on risk?

As a result from the work made on improving the foundational issues of risk analysis, Aven (2013) among others describes a three-dimensional view of risk as a combination of probability, consequences and strength of knowledge. Here, strength (the opposite of weak) is a qualitative aspect of knowledge (or knowledge-based uncertainty). Our aim was to exemplify how qualitative aspects of knowledge are taken into account in a practical situation and discuss what lessons that can be learnt. The practical situation is Chemical Safety Assessments under the European chemical regulation REACH, which often have to face knowledge gaps and for which there is a well-documented strategy to deal with aspects of weak knowledge. The European Chemicals Agency proposes that a weight of evidence approach (WoE) is to be used in cases where no single source of information is sufficient. In order to apply a WoE the reliability, relevance and adequacy (and quantity) of the evidence has to be assessed. The guidelines of information requirements make a distinction between studies that need and those that do not need a WoE. This can be interpreted as that there is a level of quality of knowledge above which a study is deemed acceptable, the key studies. These key studies are, to put it simple, ideal and “good enough”. We address three questions in connection to the WoE approach: 1) How does the WoE approach relate to the three-dimensional perspective on risk, 2) What kinds of knowledge are assumed in making the distinction between what is ideal and not?, and 3) Is it meaningful to make the distinction between ideal sources of information and other sources of information when evaluating evidence in preparation for risk assessments?

W4-I.5 Sahmel, J; Cardno ChemRisk; jennifer.sahmel@cardno.com

Evaluation of Lung Cancer Risk Associated with Take-Home Asbestos Exposure

This presentation will examine the potential implications of para-occupational (take home) and ambient background asbestos exposures in risk assessments for lung cancer. Measurements of para-occupational asbestos exposure collected in recent simulation studies for a range of simulated time-weighted average occupational asbestos exposures will be presented, along with ambient airborne asbestos concentration data collected over time. These data will be compared against both occupational and environmental standards, and their use in risk assessments will be addressed. Finally, the application of these data to evaluating lung cancer risk using different types of risk assessment approaches will be discussed.
A series of workshops has been conducted by exposure assessment experts in the American Industrial Hygiene Association to characterize the consistency and accuracy of dermal exposure judgments by human health exposure and risk assessors. The workshops have employed a new categorical dermal exposure judgment tool for ranking exposures, and the participants evaluated several different chemical scenarios using the tool to determine the estimated level of dermal exposure and risk. This presentation will provide a discussion of the results of these scenarios and lessons learned about how the participants made decisions as part of the judgment process. The relative impact of different inputs to the dermal risk assessment process will also be discussed.

**How to express the uncertainty? Application to risk ranking**

The objective of this presentation is to consider the impact of uncertainty on practical risk ranking problems. Ranking public health, animal health, environmental and economical risks is important because, while there are risks everywhere, we have restricted resources for managing them. For the purpose of this study we developed a simplified generic risk assessment model estimating the public health burden associated to a list of food and microbial hazard combinations. Disability adjusted life years (DALYs) was used as a common metric for comparing health risks associated to each considered food-hazard combination. The model needs different parameters describing food contaminations at retail level, growth and survival of the hazards during food preparation, consumption patterns and dose-response models. With respect to the representation of the uncertainty about the used parameters, probabilistic distributions were used. The model outputs provide DALYs probability distributions for each food-hazard combination. In order to establish whether a combination i is more important than a combination j, we calculated first the probability of DALYs associated to the combination i is greater that the DALY associated to the combination j. To decide on the relative importance of the two combinations i and j we choose arbitrary different threshold ranges allowing three possibilities: i is more important than j; j is more important than i; or i is equally important to j. Because of the large number of compared combinations and to avoid the combinatorial explosion of pair wise comparisons we applied the Quicksort sorting algorithms. The ranks of food-hazard combinations obtained ignoring the uncertainties can be different from that obtained by considering them. The analysis used to identify the key parameters for which a larger amount of data or more accurate information are need in order to better refine the overall ranking.

**Evaluation of the performances of the existing methods for Public health-based risk ranking of microbial hazards in the food chain**

Different approaches for the ranking public health, animal health, environmental and economical risks have already been developed by using different models and criteria with different elements and objectives. Risk Ranking works by breaking down overall risk into risk scenarios and criteria (or attributes) and evaluating those criteria and their individual contributions to the overall risk. Based on the nature and quality of available data risks can be assessed using “top-down” or “bottom-up” approaches. In principle, when data are available, the assessed criteria are assembled using mathematical or statistical models with a series of mathematical, statistical and biological assumptions: quantitative risk assessment. However, in most of the cases explicit information on criteria (e.g. prevalence of food contamination, dose response model, disease severity...) are not available and criteria may be assessed using expert opinion. In this case no direct data are available and the risk is approached by scoring the different criteria: semi-quantitative risk assessment. A scoring model may be developed to incorporate all scores to yield a single risk “score.” In general, scoring models use multiplicative or additive means to calculate risk. Very often, scores are weighted based on the importance of a score to the overall risk. Using simulated data, the different approaches were evaluated. “Top down” and “bottom up” quantitative data vs scoring system with different types of aggregation were compared. The performances of the different approaches were evaluated on their capacity to correctly rank the combinations of food-pathogens and their aptitude to integrate variability and uncertainty. The results show high discrepancy between the compared approaches. More robust scoring systems are proposed to overcome the low performances of the semi-quantitative approaches. Finally, the effects that different representations of uncertainty have on practical risk ranking was investigated.

**Assessing influence on Twitter: Reputation Risk in Networks**

Reputation is one’s most valuable asset in a networked society (de Marcellis-Warin, 2012). Social media have enabled to connect people, firms and institutions. A user’s reputation is a measure of his/her influence: the number of followers, the number of messages sent, the number of different users one has emulated, a network. On Twitter, a straightforward value of reputation is considered influential due to their relative importance in their network. On Twitter, a straightforward value of reputation is associated to each user. The number of follower one has collected is an indicator of influence. When a user is sending a message, his followers will be able to read his content. They will have the opportunity to retweet (pass the message) to their own followers, increasing the virality of the initial message. However, the number of followers do not imply that a message will be successfully transmitted. This poster will present other approaches in order to assess influence on Twitter. We collected more than 489 000 messages concerning firms listed on the S&P500. We compared different constructs regarding influence: the number of followers, the number of messages sent, the number of different users one has emulated, a network approach. Our results suggest that the number of followers is an indication of what is considered to be influential, but no one can differentiate himself by following this kind of users. The number of messages sheds light on what can be described as noisy users. The third construct give access to a more refine reputation’s value. The last method provides pure information to the one following these users. The new methods of accessing influence on Twitter leverage the management of reputation risk for firms in a social media era.
T4-C.3 Santos, JR*; Paguyoin, SAT; Herrera, LC; Tan, RR; Yu, KDS; George Washington University; joost@gwu.edu

Analysis of Drought Risk Management Strategies using Dynamic Inoperability Input-Output Modeling and Event Tree Analysis

Climate change is expected to increase the frequency and intensity of droughts in many parts of the world. Since water is an essential resource for many economic activities, water scarcity can cause disruptions that manifest as losses in industrial outputs. These effects can propagate through economic systems as a result of the inherent interdependencies among economic sectors. Risk management strategies for droughts must therefore account for both direct and indirect effects of water supply disruptions. In this work, we propose a methodology for evaluating drought management strategies by combining economic input-output modeling with event tree analysis. We apply the methodology to a simulated drought scenario affecting the urban region of Northern Virginia, USA. Three risk management strategies, namely, reducing the initial level of water supply disruption, managing water consumption, and prioritizing water-use dependencies, are evaluated based on inoperability levels and cumulative economic losses. Results show that while managing water consumption yields the lowest cumulative economic losses in the region, reducing the initial level of water supply disruption and prioritizing water-use dependencies result in lower inoperability of critical sectors. These findings provide insights for decision makers in identifying critical sectors and formulating timely intervention strategies that minimize the over-all effects of drought to economic systems. Further, the proposed modeling framework for drought risk assessment can be applied to other regions to evaluate the effects of drought severity and management strategies over the drought timeline.

T2-B.1 Sarofim, M; Waldhoff, ST*; Anenberg, SC; Pacific Northwest National Laboratory; Stephanie.Waldhoff@pnnl.gov

Valuing the ozone-related health benefits of methane emission controls

Methane is a greenhouse gas that oxidizes to form ground-level ozone, itself a greenhouse gas and a health-harmful air pollutant. Reducing methane emissions will both slow anthropogenic climate change and reduce ozone-related mortality. We estimate the benefits of reducing methane emissions anywhere in the world for ozone-related premature mortality globally and for eight geographic regions. Our methods are consistent with those used by the U.S. Government to estimate the Social Cost of Carbon (SCC). We find that the global short- and long-term premature mortality benefits due to reduced ozone production from methane mitigation are ($2007$)$8745$ and $1675$ per tonne methane, respectively. These correspond to approximately 70% and 160% of the valuation of methane’s global climate impacts using the SCC after extrapolating from carbon dioxide to methane using Global Warming Potential (GWP) estimates. Results are most sensitive to the choice of VSL, and increase for emission years further in the future. Regionally, most of the global mortality benefits accrue in Asia, but 10% accrue in the United States. This methodology can be used to assess the benefits of any methane emission reductions anywhere in the world, including those achieved by national and multinational policies.

P.76 Sax, SN*; Pizzurro, DM; Zu, K; Lynch, HN; Prueitt, RL; Goodman, JE; Gradient; ssax@gradientcorp.com

Weight-of-Evidence Evaluation of Short-term Ozone Exposure and Cardiovascular Biomarkers

The US Environmental Protection Agency (US EPA) recently determined that there is likely to be a causal relationship between ozone and cardiovascular (CV) effects; however, a biological mechanism has not been established. Some studies have assessed changes in circulating levels of biomarkers after ozone exposure to elucidate a biological mechanism, focusing on biomarkers associated with inflammation, oxidative stress, and coagulation. We conducted a weight-of-evidence (WoE) analysis to determine if there is evidence supporting an association between changes in these biomarkers and short-term ozone exposures that would indicate a biological mechanism for CV effects below the ozone National Ambient Air Quality Standard (NAAQS) of 75 ppb. Our evaluation followed an updated WoE framework that was based on US EPA’s NAAQS framework and was consistent with recommendations in the National Research Council’s “Review of EPA’s Integrated Risk Information System (IRIS) Process.” We identified only a few controlled human exposure studies, all of which were conducted at ozone concentrations above the NAAQS. These studies showed small elevations in biomarkers for inflammation and oxidative stress, but most were not statistically significant, and there was no evidence of an effect on coagulation biomarkers. Epidemiology findings were mixed for all biomarkers, with only a few studies reporting statistically significant changes and with no consistency in the direction of the reported effects. Animal studies showed more consistent results among certain biomarkers, although these were also conducted at ozone exposures well above the NAAQS, with limited information on dose-response relationships. Overall, there was a general lack of coherence among controlled human exposure, animal, and epidemiology studies. Our WoE analysis of biomarker data indicates that there is little evidence to support a biological mechanism for CV-related effects from ozone exposure below the current NAAQS.
Understanding risks and context uncertainties: The CIB approach in energy systems analyses

In times of increased energy transition ambitions of governments worldwide, scenarios are popular means for policy-makers to consider, analyse and evaluate potential future energy states. The focus of their modelling and systems simulations is on analysing the range and complexity of technical and economic aspects. Yet, energy systems are embedded deeply in society and transition processes are also dependent on organisational, political, legal, social and cultural variables that are in themselves highly interdependent, complex and uncertain. Neglecting uncertainties and complexities of these variables thus means leaving out relevant information on the total system energy technologies and infrastructures are part of and may produce conclusions that do not reflect the societal context in which they act. In order to clearly communicate the societal dynamics that embed energy systems developments, a systemic analysis is needed. I propose to apply the Cross-Impact Balance Analysis (CIB), a qualitative systems analysis that has several benefits: It captures interdependencies between the system variables, it embraces uncertainties by considering multiple plausible development of a variable and it enables the integration of interdisciplinary knowledge based on expert surveys. From CIB internally consistent ‘context scenarios’ in the form of mutually supporting impact networks can then be identified and may further serve as the basis for quantitative energy system modelling. Making societal parameters’ inherent uncertainties and complexities more transparent, hence, enriches scenarios’ role as a communication tool and helps policy-makers get an understanding under what societal conditions energy models may likely unfold. The approach therefore has the potential to support policy-makers in developing better-informed, robust policies measures.

Public Participation: Opportunities and Limitations to manage emerging risks

In contrast to familiar hazards, emerging risks are difficult to detect and to assess in advance. In many cases little is known about triggering effects because of complexity and long periods of latency. For risk managers emerging risks pose a challenge for management processes with a strong emphasis on monitoring and framing. In addition to factual knowledge, evaluation-based knowledge is important to enhance the acceptance of a risk or the measures to cope with its consequences. Therefore public participation methods are established in many cases. But are these methods suitable in the case of emerging risks? There are several points to discuss for example: • Emerging risks point at a long period of latency while the public attention is mainly related to current issues. How can public participation processes established in advance? • Many emerging risks are unknown to science or professional risk managers. Can public screening be a possibility to serve as an early warning system? • Preparing for emerging risks implies investment in precaution that may not be efficient? How can public input be used to find the best tradeoff between efficiency and resilience? • Often emerging risks appear out of the blue, for example with pandemics. What role can public participation play in preparing for such a case? The poster will discuss the opportunities and limitations of public participation to manage emerging risks.
P.168 Schultd, JP*; Eosco, GM; Rickard, LN; Daziano, R; Scherer, CW; Schultd, JP (Cornell University); Eosco, GM (Cornell University); Rickard, LN (SUNY ESF); Daziano, R. (Cornell University); Scherer, CW (Cornell University); jps56@cornell.edu

**A Tale of Two Storms: Recalling the Risk of “Hurricane” versus “Superstorm” Sandy**

Risk communication scholars are increasingly interested in the message factors that shape the public’s response to severe storm information. Only recently, however, have scientists begun to study the influence of the names given to storms, as when female-named storms are perceived as less risky than their male-named counterparts (Jung et al., 2014). In this vein, we conducted an experiment to assess whether describing a severe storm as a “hurricane” or “superstorm”—the latter of which became a frequent descriptor in Sandy media coverage and related public discourse—might similarly shape risk perceptions among the storm-vulnerable public. In the Summer of 2014, we surveyed a diverse sample of N = 158 residents living in areas that were directly impacted by Sandy and its devastating storm surge (the greater New York metropolitan area). In a split-ballot experimental design, respondents were asked to recall how severe they believed “Hurricane Sandy” or “Superstorm Sandy” was going to be before the storm hit. Moreover, participants completed self-report measures to assess the extent to which they or others close to them were directly impacted by Sandy (the greater New York metropolitan area). We validated these findings by analyzing over 3,000 survey responses to examine if and how the decision to evacuate).

P.167 Seena, AS; Norwegian Afghanistan Committee (NAC); sultani.aliseena@gmail.com

**Integrating Strategic Risk Communication with Risk Assessment to Achieve Targeted Risk Management Outcomes**

Experience within our programs show that risk communications are often and unplanned reaction to emerging needs. Resulting shortfalls in communication conditions and ad-hoc responses create needless controversies and increased costs; making the risk management process more complicated, and may contribute to eroding trust among key stakeholders. A strategic approach to risk communications that can help avoid such challenges and would thus provide important benefits to decision-makers and stakeholders alike. Strategic risk communication includes both content of communication and interaction influencing risk decisions and behaviors; including announcements, warnings and regulations. It may be communicated verbally, in writing or through visual images, while the content may describe risks or characterize their importance as well advocate for mitigating actions. Interactions include everything from engaging individuals one-on-one or in smaller groups to broader, more formal stockholders engagement and consultation processes. NAC does this among other when communicating with Community Development Councils (CDCs) and women self-help groups (SHGs). Effective risk communications must be relevant to the needs of stakeholders and sensitive to their beliefs, feelings and contexts. Approaches for designing strategies for risk communications must be grounded on current understanding, 2 Develop communications strategies sensitive to stakeholders current thinking, goals and choices, 3 Pre-test strategies, plans and messages, 4 Implement according to plans, 5 Monitor risk communication process and outcomes. The Strategic Risk Communications Process provides step-by-step details of activities to support every step in the process: Define the opportunity, Characterize the situation, Assess stakeholder perceptions of the risks, benefits and tradeoffs, Assess how stakeholders perceive the options, Develop and test strategies, risk communications plans and messages, Implement risk communications plans, Evaluate the effectiveness of risk communication.
Foresight tools for responding to cascading effects in a crisis

Cascading effects pose a major challenge in a crisis and disaster situation. The effects can be technical as well as social, affecting unexpected systems or triggering unwanted behavior by the public. Especially if the degree of technical and social preparedness is rather low, cascading effects might lead to major negative consequences, i.e. a more severely damaged infrastructure, higher losses, and a longer time needed for recovery. A model is proposed to intervene in current crisis response practices by bridging the gap between the over-reliance on unstructured information collection on one side and a lack of attention to structural, communication and management elements of cross-border and cascading crisis situations on the other. Information and communication tools and models are discussed, intended to assist stakeholders in evaluating what information is significant and relevant. These new approaches are part of the research project FORTRESS and will be systematically build by using evidence-based information from historical crisis case studies, as well as comprehensive analysis of the different relationships between systems, and systems and sensitivity information from current crisis management contexts and practices in four system simulations. This will enable to build a collaborative and accessible modeling platform for cascading and cross-border effects in a range of crisis situations. An Incident Evolution Tool (FIET) will be proposed, a user-friendly tool with cross-border capabilities that can be used in a cascading crisis. FIET can be used as a foresight tool to assist decision-makers in understanding the potential effects of their decisions in training environments.

The Impact on the Survival of Small Business: A Probabilistic Approach

The Regulatory Flexibility Act as amended by the Small Business Regulatory Enforcement Fairness Act requires federal agencies to analyze how their regulations will affect small entities. If the effects on small entities are found to be substantial, federal agencies are required to assess alternative forms of the regulation and develop compliance assistance for businesses in order to minimize burdens on them. Despite the statutory requirement for measuring the effect of regulations on small businesses, time and resource constraints preclude undertaking surveys and other activities needed to generate the data to analyze individual regulations. Thus, it is not surprising that many federal agencies “...do not conduct rigorous... analyses to quantify the impact of a rule on small entities.” Moreover, the manner in which federal agencies evaluate effects varies widely. Some federal agencies measure impacts by comparing compliance costs to revenues, others consider only compliance costs without relating them to any measure of firm performance (e.g., revenues, profits), and some only conduct a qualitative assessment of impacts. In light of the constraints faced by federal agencies, we have created a generic cost impact assessment model that will allow policy analysts to conduct timely and inexpensive analyses of regulatory impacts on small businesses. The model is based on accessible information and basic economic principles and can be used to assess different regulatory policies and industries. In this study, we use the model to estimate the impact of regulations on the probability of survival of small business. The model generates probability estimates of closure vulnerability for different-sized establishments by comparing pre- and post-regulation cash flows. In this as in its other applications, the model aims to strike a workable balance between simplicity and reality.

Examining the Social Value of Antibacterial Drugs

Antibacterial resistance is a growing global problem. Despite the potential of new antibacterial drugs to reduce the social burden associated with resistant infections, some of the large companies have been exiting these markets in recent years. These market exits have been primarily driven by insufficient returns to capital invested in the development of these products. In an earlier study, we examined the private returns to these products and shown that, in most cases, they are lower than the threshold needed for undertaking drug development. In this study, we estimate the potential social value for these antibacterial drugs to assess the extent to which these private values fall short of the societal importance of these drugs. Similar to private returns, we find that there is wide variation in the estimated social values across the different indications. The primary drivers for the observed wide range of social return results are attributable to, in order of importance, the model parameters for the percentage in disease duration for patients that do not respond to commonly used antibacterial drugs; phase 1 clinical trial success probability; pre-clinical R&D success probability, and the real annual social rate of discount. Despite the high degree of variability, however, even the lower bounds of these social values are greater than the estimated private returns by orders of magnitude.

The Influence of Interactive Maps and Data Sufficiency on Risk Beliefs, Ambiguity, and Behavioral Intentions for Maps Depicting Water Test Results for Private Residential Wells

Increasingly, interactive maps are used to communicate environmental health risk information to the public. It is important to convey the sufficiency of the data used to generate risk information displayed on maps. Color saturation was used to symbolize data sufficiency, with less and more saturation signifying less and more data sufficiency. This 2 x 2 x 2 factorial study was designed to assess the influence of interactivity (static, interactive) and data sufficiency (not sufficient, sufficient) for maps that varied by two zoom levels and two collective levels of the hazard (lower, higher). Dependent variables were: risk beliefs, emotion, ambiguity, and behavioral intentions. Maps depicted fictitious water test results for private residential wells. University students (n = 370) participated in the online survey study by answering survey questions as they viewed study maps for an assigned map location. Structural equation modeling will be used to examine the influence of map variables on dependent variables. These influences will be examined within a context of participants’ characteristics that include prior risk beliefs and drinking water behaviors, numeracy, sex, and major area of study. The moderating influence of numeracy will be explored. Study results will be shared in this presentation.
**WI-G.3** Shamoun, DY*; Calabrese, EJ; Mercatus Center at George Mason University; dshamoun@mercatus.gmu.edu

**Risk Assessment Report Card**

Federal guidelines on how regulatory agencies should conduct sound risk assessments date back to the early 1980s. Risk assessment is a widely applied technique by regulatory agencies to evaluate the risk of exposure to potential hazards. In this project we build on the federal guidelines released by the National Academy of Sciences, National Research Council, and the Office of Information and Regulatory Affairs to develop a scoring system as a metric of the quality of risk assessments. More specifically, we identify four broad categories of a sound risk assessment: Analysis, Robustness, Openness, and Review. We develop a per-category pass/fail score to better distinguish the strengths and weaknesses of different risk assessments. This methodology can pave the way for a more objective evaluation of the science used by regulatory agencies to regulate risk of exposure to different health, safety, and environmental hazards.

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**T2-D.2** Sheehan, T*; Gestautas, S; Raytheon; Timothy J Sheehan@raytheon.com

**Product Materials Declaration for Military Hardware Products: Promoting Risk Management**

Military hardware products produced by defense contractors often contain and use chemical materials posing significant risks to the military customer and/or the environment. These risks include direct impacts on human health and safety and the environment from hazardous materials; non-compliance with increasing regulatory requirements related to the proper management and disposal of hardware; the misallocation of materials that is not reflective of their value, and the loss of availability of materials needed to produce and sustain military hardware is supported by hazard communication and specification information requirements, there is no corresponding mechanism to identify the materials of construction of the hardware. Therefore, those materials are often not identified, making materials risk identification and management challenging at best, a situation that is compounded by the use of commercial products (with limited materials composition information) as components. Recent collaboration between the Department of Defense and the US defense industry is addressing the issue; at the same time, an international aerospace and defense industry effort is in development to obtain materials composition information through the hardware supply chain. With the understanding of the materials of construction, the designers of military hardware are better able to eliminate or reduce related risks in the design phase, when it is most efficient and cost-effective to do so.

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**T3-G.2** Shao, K*; Allen, BC; Farrar, D; Chiu, W; Cowden, J; Gift, JS; 1. Indiana University Bloomington; 2. Independent Consultant; 3, 4, 5 and 6. US EPA; kshao@indiana.edu

**Bayesian Probabilistic Dose-Response Analysis Using Epidemiological Data**

Traditional dose-response analyses estimate population risk using a cancer slope factor (CSF) for cancer risk assessments or reference values (RfV) as a “safe” level for noncancer assessments. Although procedurally straightforward, the current methods are limited. In particular, the RfV approach has been criticized for its inability to quantify risk above or below the RfV and the CSF approach is limited in its consideration of various sources of uncertainty and variability. To overcome these limitations, a number of researchers and expert panels have recommended using probabilistic approaches. Additionally, probabilistic risk characterization is more informative for quantitative economic (risk-benefit) analysis to further support risk management. This study employs a probabilistic approach to quantitatively estimate risk with confidence interval at low dose levels using dose-response data from epidemiological studies. The proposed method developed in a Bayesian framework involves considering and quantifying between-study uncertainty, between-model uncertainty and within-model uncertainty. The methodology is illustrated using a case study of the relationship between arsenic exposure via drinking water and bladder cancer.

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**WI-C.5** Sherry, J*; Curtis, A.; Laird, S.; Toman, E.; Charles Sturt University; jsherry@csu.edu.au

**The Social-Cultural Context of Risk in Rural Nepal**

Disaster risk reduction efforts seek to identify adaptation strategies that reduce vulnerability and mitigate hazard impacts for at-risk human populations. Mounting theoretical discourse investigates the state of vulnerability within a social system in terms of exposure, sensitivity, and the adaptive capacities by which people can respond to stressors through context-specific adjustments. The conceptualizations and applications of this research have typically focused on measuring a set of tangible indicators explained in terms of physical and socio-economic factors. Yet, a multitude of other factors likely influence how risks are prioritized, amplified, or attenuated. There is a growing recognition that the underlying psychological and cultural characteristics that drive people’s risk interpretation, decisions, and behavior are important but often disregarded aspects of vulnerability and adaptation discussions. The present study will employ mixed qualitative methods to investigate the underlying social-cultural characteristics that influence risk interpretation and vulnerability in the Dolakha District of central Nepal. Rural populations in this region are threatened by a number of natural hazards that are predicted to intensify with global environmental changes. Preliminary findings from the literature review and the first stage of data collection will be presented.
For its widespread application on agriculture and disease control, 1,1,1-Trichloro-2,2,2-Trifluoroethane (DDT) had become ubiquitous in Taiwan in 1962 following its introduction. However, it is reported that some of the imported pesticides, processed foods, and river water still remain DDT and DDE. Also, epidemiological studies showed that prostate cancer, liver cancer, diabetes, and pancreatic cancer have positive associations with exposure to DDT and other pesticides. Therefore, we cited the NCI’s mice and rat data to estimate dose-response relationship in USEPA’s Benchmark Dose Software and conduct a health risk assessment applying Bayesian statistics to multimedia CalTOX model and use OpenBUGs to derive posterior distribution of parameters. We collected landscape data and concentrations data of some media on our own. About parameters without credible reference research, we applied Bayesian statistics, then we can obtain the unknown concentration in other media. We also collected the concentration of DDT and DDE in several kinds of food and combined the intake rate data for foods from the Taiwan National Food Consumption Database to calculate the LADD via Bayesian statistics. The lower estimated excessive risk of DDT (3.57E-07) meets our expectation because it is almost no input to the environment now. And the estimated excessive cancer risk of DDE for 19-65-year-old adults is 4.63E-06, and 1.99E-05 for 0-3-year-old children. Compared to DDT, the risk of DDE does not diminish to an acceptable range, especially for 0-3-year-old children. It is probably because DDE is the most common metabolite in animal and human body, and also in environment. This result indicates that it is probably necessary for the government to keep monitoring the concentration of DDT and DDE in these environment media and food items and educating the public to decrease the exposure to DDT and DDE.

**T4-K.3 Siegrist, M*; Sütterlin, B; ETH Zurich, Switzerland; msiegrist@ethz.ch**

**The Affect Heuristic Influences Perception of Probability Information**

According to the affect heuristic, people may use the affect evoked by a hazard for assessing its associated risks and benefits. We hypothesized that the affect heuristic may even influence the perception of probability representations. Participants (N = 205) were randomly assigned to one of two experimental conditions: gene technology (GT) or conventional technology (CT). Participants’ affect associated with GT or CT plants were measured. Then participants read a hypothetical scenario about a new, genetically modified (GT condition) or conventionally produced (CT condition) maize line that was more tolerant to the European corn borer. A cell matrix with 1,976 randomly scattered, black (50%) and white (50%) cells was presented. Participants were informed that each cell represented a research plot and that the maize plants in the white research plots were not affected by the corn borer. Participants were then asked about the percentage of plots in which the corn borer had been observed and how effective they perceived the new maize line was. Results suggest that the participants in the GT condition perceived the new maize line as significantly less effective, compared with their counterparts in the CT condition. No significant difference was observed for estimated percentages. Results further support the hypothesis that in the GT condition, the affect heuristic was important for participants’ assessments. The participants who had negative affects associated with GT estimated a higher percentage of plots afflicted by the corn borer, compared with those who had positive affects associated with GT. Furthermore, these estimates were significantly positively correlated with the assessed effectiveness of this new maize line. None of these correlations was significant in the CT condition. Results suggest that the affect heuristic can influence the perception and interpretation of objective risk information.
When (In)Action Speaks Louder than Words: The Collapse of Humanitarian Values in Foreign Policy Decisions

Decisions to save civilian lives by intervening in foreign countries are some of the most difficult and controversial choices facing government officials. Among the many factors influencing such unique, decisions involving tradeoffs that pit the value of human lives against other important objectives are quite common. Furthermore, there is often a striking disconnect between the high value placed on saving human lives expressed by top government officials and the apparent low value revealed by government decisions not to intervene. Specifically, when multiple objectives are in play, highly regarded humanitarian values seem to collapse in the competition with national security and economic security objectives. On the basis of theoretical models of judgment and choice, research in social cognition, and careful reading of official statements, we have developed a hypothesis to explain this collapse. Underlying our hypothesis is the “prominence effect” (Tversky, Sattath, and Slovic, 1988), which asserts that choice is inherently more lexicographic than expressed judgments of value. That is, the more prominent attributes of a proposed action will be weighted more heavily in choice than in judgments and decisions based on expressed preferences or values. We argue that the prominence effect may underlie the disconnect between expressed preferences and revealed behavior whether or not to act to save large numbers of civilian lives under attack in foreign countries. Specifically, we hypothesize that national security is the prominent dimension in the context we are studying here. Chosen actions need to be justified, and deciding in favor of security likely makes a stronger argument than deciding in favor of saving foreign lives, no matter how many thousands or millions of lives are at stake. We shall discuss the moral, ethical, and strategic implications of this bias that devalues efforts to intervene in massive humanitarian crises.

Proponents of shale gas development argue that it has ushered in a new era of clean domestic energy, while posing modest environmental risks. In contrast, opponents argue that it poses significant upstream, operational and downstream risks, and is currently implemented with inadequate regulation and oversight. There is sufficient experience and scientific evidence to support or refute these opposing views? Where is additional research most needed for improved understanding and management of shale gas technology, its risks, and its governance? To begin to address these questions the U.S. National Research Council Committee on Risk Management and Governance Issues in Shale Gas Development convened two workshops in 2013. This presentation summarizes key findings from those workshops. Risk domains considered in the first workshop included operational risks (accidents, leakage, and induced seismicity); impacts on water supply and water quality; local, regional, and global air pollution impacts; effects on global climate change; ecological effects associated with habitat disruption and toxicity; human health effects; and socioeconomic impacts on affected communities. The second workshop addressed the current state of governance in the U.S., Europe, and other countries, as well as new initiatives for governance involving voluntary performance standards by industry; requirements for comprehensive shale gas development plans; and possible scenarios for an increased Federal role in research, information collection and dissemination, and supporting regulations.

Climate change impacts on food and water safety: A quantitative microbial risk assessment framework

Climate change may be a factor leading to increased risks of food- and waterborne illness from emerging and re-emerging biological hazards. It is beneficial to develop integrated approaches to evaluate, and provide scientific assessments of, potential climate change adaptation measures to inform risk management related to climate and weather events. To this end, a risk modelling framework was created to facilitate estimations of the impact of weather and climate change on public health risks from microbiological hazards in food and water and to compare potential adaptation and risk mitigation strategies. The framework integrates knowledge synthesis methods, data storage and maintenance, and stochastic modelling. Interactive risk assessment models were developed within the framework that link climate data, hazard behaviour and virulence, contamination and exposure events, and population vulnerabilities to forecast likelihood and magnitude of adverse health impacts in different regions of Canada. Risk assessment models were developed for food and water safety case studies. Scenario analyses indicated that implementing intervention measures to adapt to changing climate impacts might mitigate future public health risks from pathogens to varying degrees. Success of adaptation efforts seems dependent, in part, on the specific biological hazard, commodity, and population considered. The framework brings a generic approach to allow for comparison of relative public health risks and potential adaptation strategies across hazards, exposure pathways, and regions to assist with preventive efforts and decision-making.

Understanding, communicating and mitigating risk through motivation

It is useful to distinguish between risks (consequences, probabilities) in relation to stochastic physical and natural phenomenon such as pollution, drug side effects natural disasters and residual risks that the population of interest is exposed to as a consequence of human action or lack thereof. By residual risk, we mean the risk that remains when we take into account human efforts that may determine if there will be an incident and the potential consequence. Furthermore, it is necessary to distinguish between the understanding of risk exposure (risk analysis) and risk control (management). Risk is an inherently subjective concept in that an event that is considered undesirable by some, may be considered highly attractive by others. Conflicting Incentives Risk Analysis (CIRA) is a framework for identifying and analyzing motivational factors and actions that impact residual risks. CIRA addresses issues such as the existence of moral hazards - where there is poor balance between the distribution of benefits (goods) and losses (bads). Risk management then becomes an exercise in trying to create better balance and motivational alignment between those affected by the event and the party that initiates the events of interest. CIRA is novel in several aspects - e.g. it captures important aspects of risk without having to rely on probabilities, making it particularly attractive when probability estimates are difficult to obtain. This is relevant when it is difficult to agree on the correctness of small probabilities. To illustrate how CIRA frames risk, we will give several examples taken from cases such as hydraulic fracturing, legalization of marijuana and the Colorado floods.
Determination of in-stream eDNA sampling for monitoring the presence of invasive Asian carp

Early and accurate detection of invasive species is critical to effective aquatic ecosystem management. Environmental DNA (eDNA) sampling is being rapidly adopted as a detection tool due to its improved sensitivity and cost-effectiveness. However, the implementation of eDNA sampling in current decision-making frameworks, such as the management of invasive Asian carp species, has been challenging due to the uncertainties in the relationship between species presence and species eDNA. In this study, a Bayesian Belief Network (BBN) methodology is developed to integrate these uncertainties to evaluate in-stream Asian carp eDNA detection performance over a range of eDNA laboratory detection methods. A water quality simulation model is developed to predict the relationship between Asian carp density and eDNA concentration and a statistical model for the background eDNA concentration is developed using historical observations. These are combined within the BBN to determine the conditional probabilities of eDNA detection given Asian carp presence or absence over the range of laboratory detection methods. The BBN finds that highly sensitive laboratory methods, such as laser transmission spectroscopy, greatly reduces the false negative rate but will be more prone to false positives due to picking up the background eDNA concentration. The BBN also finds that eDNA detection performance in general is highly dependent on species characteristics, which influences both species presence and eDNA concentration. A stronger understanding of the uncertainties in eDNA sampling and detection performance will help improve sampling methodologies and more effective integration within decision-making frameworks.

Health Impact Assessment: An Emerging Trend for Oil and Gas Projects in the US?

Projects across many sectors have the potential to influence population health. Health Impact Assessment (HIA) seeks to identify and estimate potential health risks and benefits from projects or policies on a population. HIA is based on the principle that health, as defined by the World Health Organization, is "a state of complete physical, mental, and social well-being and not merely the absence of disease". In many countries, HIA is often required or incorporated into best practices in the oil and gas industry. Very few HIAs have been conducted in the United States' oil and gas sector (with the exception of Alaska). However, HIAs in the US are increasingly being promoted by a number of organizations, including the Centers for Disease Control and Prevention, the National Research Council, and many State and County public health departments. We predict that HIAs will become increasingly common with expanding oil and gas production in the US and the public concerns surrounding the growth of unconventional oil and gas development using hydraulic fracturing (commonly referred to as "fracking") and other well stimulation techniques. This poster discusses the possibility of HIA becoming a systematic part of the decision making process for the approval of oil and gas development projects. The poster also presents a case study on an HIA recently conducted for an oil drilling and development project on a 1.3-acre site within 100 feet of businesses, 150 feet of residential areas, and 55 feet of a park in a California beach city. The City commissioned an HIA to implement a required Environmental Impact Report and to inform decision-makers about potential health risks and/or benefits of the project. Lessons learned from this HIA will inform strategies to successfully complete HIAs for other oil and gas development projects.

Perceived risk of extinction for species depends on assessment criterion applied

The IUCN Red List published by the International Union for Conservation of Nature is an inventory of extinction threat assessments for a vast number of species. Using the threshold values and criteria employed for various assessment criteria, this study examined whether such threshold values that are consensually deemed equivalent in extinction risk by conservation experts are also deemed equivalent by non-experts. We expected differences in perceived risk and policy priorities across presumably equivalent risk information assessed with different criteria because psychological studies have consistently found that some expressions of statistical information are more likely to create affect-laden images in people's minds which, in turn, causes higher levels of perceived risk. In an online experiment, 306 participants were randomly assigned to three groups (Critically Endangered, Endangered, Vulnerable) in each of which they read six presumably equivalent threat descriptions of anonymous species that varied in assessment criteria. Participants were instructed to think that they were offering opinions as citizens in public hearings to help establish priorities in conservation efforts. They were asked to report their perceived risk for each species first, and then, rank-order the conservation priorities for each species. Results show that, as hypothesized, there were significant differences in the participants' values on the assessment criteria applied. Participants tended to judge species described with criteria apparently involving vivid imagery (e.g., number of individuals left) as facing higher risk and assigning higher priority than those assessed with criteria harder to visualize (e.g., probability of extinction in defined period). Analysis of individual differences found that in lower-risk conditions, rational thinkers perceived the risk expressed in probabilities as significantly lower than did experiential thinkers.

Climate Change Scepticism and Adaptation – A Fresh Start

While there is overwhelming expert consensus on the fact that human activity is contributing to climate change, voices that doubt or even reject the idea of anthropogenic climate change still exist. Advocacy and ideological component as conservative audiences have been found to be consistently associated with more sceptical responses. The guiding theme of the present research is that climate change scepticism can be understood as a cognitive defence-mechanism in response to a misalignment between aspects of a person's identity and proposed mitigation measures. I apply a cognitive theory of stress framework integrating work on identity protective cognitions to investigate the role of climate change measures in the formation of these highly polarized perceptions. I will present results of a comprehensive initial survey (N=268) that was conducted in the UK, investigating psychological determinants of support for, and intention to perform, adaptation and mitigation measures. I will discuss results from a series of multiple regression analyses, focusing in particular on the surprising result that scepticism serves as a positive predictor of adaptation intentions. I will then present results of a quasi-experimental study (N=250) that showed how framing climate change in terms of adaptation at the local scale, rather than mitigation at a global level, induces less partisan interactions with climate change overall. The final discussion will concentrate on the implications of these findings for the development of more effective risk communication interventions and for policy makers.
M4-C.3 Sridharan, S*; Mangalam, S; Reid, D; Mulamootil, L; Bharati, R; Technical Standards and Safety Authority; ssridharan@tssa.org
Risk Informed Regulatory Decisions – A Review of Case Law in Canada
Regulatory agencies have been applying best practice risk management principles for decisions made in the public interest. The nature and extent of the applications of these principles are varied and diverse as dictated by the prevailing rules, regulations, and the degree of scrutiny. These decisions, in many circumstances, are subject to challenges in the court systems and the outcomes. This paper examines such scrutiny of risk-based regulatory decision making by reviewing several examples in case law in Canada. For the purposes of review, this paper defines public risk management as the process of managing the “risk source (generators of risk) - risk bearer (receptor of risk)” relationship and examines the views of the courts in their assessment of the adequacy of such frameworks. Using examples that cover food safety, public communication, road safety, and public health, this paper reviews, from the perspective of the Crown and the Defence, how the risk source(s) and risk bearer(s) relationship is characterized. The paper describes how the courts have weighed the evidence and quality of evidence presented by both the Crown and the Defence, against multiple societal values that may be compromised and the minimum standards that have been used to conduct the evaluation of evidence versus values. The paper is intended to provide guidance to regulatory agencies on the expected minimum standards in risk management when applied to making decisions in the public interest.

M4-H.A Stahl, C*; Martin, L; Brewer, B; U.S. Environmental Protection Agency; stahl.cynthia@epa.gov
Trying to do it all for cumulative risk assessment: The feasibility of the Multi-criteria Integrated Resource Assessment (MIRA) approach
A cumulative risk assessment that involves multiple stressors/receptors, quantitative and qualitative information, human health and ecological factors, and must address uncertainties is a difficult assignment for any science-based methodology. For this reason, tackling this assignment requires borrowing components from a wide range of disciplines including some that are beyond traditional science approaches. These disciplines include risk assessment, risk management, game theory/decision analysis, social values/stakeholder participation, adaptive management, public policy making, and uncertainty analysis. The Multi-criteria Resource Assessment (MIRA) approach is specifically designed using the most desirable components of these disciplines in order to meet stakeholder needs where complex tradeoffs exist. MIRA is a special example of a multi-criteria decision analytic approach that guides stakeholders (including decision makers) through a transparent, learning-based process of engagement and discussion to clarify and articulate context, understand the role of experts and expert judgments and the role of stakeholder values, and the uncertainties related to each of the components as well to the combination of those components.

W4-A.2 Staid, A*; Pinson, P; Guikema, SD; JHU and DTU; staid@jhu.edu
Probabilistic Maximum-Value Wind Prediction for Offshore Environments
High wind speeds pose significant risks to structures and operations in offshore environments. Performing maintenance on wind turbines, for example, is considerably more dangerous during periods of high winds. Anticipating periods of high winds allows operators to plan for them and therefore increase the safety and reliability of workers or components in affected operations. There is a need to accurately predict periods of dangerously high winds so that decisions can incorporate this information. In contrast to many wind forecasting models, which focus on average wind speeds in a given time period, we present statistical models and training methods to predict the distribution of maximum winds. With a response variable of maximum wind speed in a three-hour interval, we assess the performance of linear models, GAMs, and MARS models using meteorological covariates from ECMWF forecasts. We apply our models to a location in the North Sea. We are able to accurately predict maximum winds across lead times from zero hours to five days. The models outperform traditional baseline methods, and we show their predictive accuracy across lead times and different training methodologies. These simple statistical models, which provide knowledge of the maximum wind speed, may allow for more informed decisions regarding wind turbine operations, planned maintenance, and power grid scheduling for improved safety and reliability. The probabilistic nature of the predictions offers a greater value to the end user in order to improve decision-making for offshore operations.

W2-H.2 Steinmaus, C; UC Berkeley School of Public Health; craigs@berkeley.edu
Concomitant exposure to multiple goitrogens: Implications for regulation
Exposure to goitrogens such as perchlorate, nitrate, and thiocyanate is of regulatory concern because goitrogens interfere with iodine uptake by the thyroid gland, potentially leading to insufficient thyroid hormone levels and putting children and the developing fetus at risk of neurodevelopmental deficits. Recent work based on NHANES and other data has shown that people with low-end or high-end iodine intakes, high urinary perchlorate, and exposure to other goitrogens like thiocyanate have significantly lower serum thyroxine levels than those with adequate iodine and low urinary perchlorate and thiocyanate concentrations. Those results highlight the importance of examining the combined effects of multiple agents when evaluating the toxicity of thyroid-disrupting agents and suggest that efforts to regulate individual goitrogens should consider concomitant exposures to multiple goitrogens, which are more widespread than previously thought.
**A case study of the application of systematic review to toxicology: The Zebrafish Embryo Test as a predictor of mammalian pre-natal developmental toxicity**

Systematic reviews and their components, including evidence identification, evaluation, and integration, are beginning to be applied to toxicology. These tools were developed to overcome shortcomings of traditional narrative reviews in medicine and health care, in an attempt to bring greater transparency, objectivity, and consistency to evidence assessment. The procedures for systematic reviews need to be adapted and optimized for use in toxicology. This translation will be facilitated by experience. The Evidence-Based Toxicology Collaboration (http://www.ebtox.com), which seeks to promote evidence-based methods in toxicology, has undertaken its first systematic review. It seeks to assess the literature on a new test method as a predictor of the results of the corresponding routine test, in a process parallel to diagnostic test assessment. Specifically, the Zebrafish Embryo Test (ZET) is being assessed as a predictor of pre-natal developmental toxicity in rats and rabbits. The ZET has advantages over the mammalian-based assays in terms of speed, cost, and animal use. A working group drafted a protocol that addresses how each of the steps in the review will be carried out. These steps include problem formulation, literature search, study eligibility, data extraction, study quality, and data integration. Given the novelty of this test, the group carried out systematic reviews in toxicology, the protocol was implemented first as a pilot project. Following that, the protocol will be revised as appropriate and implemented definitively. Lessons learned to date are presented as preliminary results will be presented. As more systematic reviews are conducted in toxicology, improvements in the process can be made.

**A gap analysis of the hazard knowledge available for nanomaterials**

In order to inform risk assessment of nanomaterials we currently need to get a broad, but thorough understanding of hazard to human health. This includes hazards after different routes of entry (inhalation, ingestion, dermal or injection), at different locations (portal of entry and distal organs), as well as at different nanomaterial life cycle stages (e.g. pristine, modified and aged). While research is conducted across many of these areas, there are clear gaps in knowledge which are impeding both risk assessment and the future streamlining of the risk assessment process. In order to identify these gaps, a systematic analysis of current literature (PubMed) was conducted using a series of search terms designed to capture as many relevant publications as possible. The search results were presented as heat map tables that allowed identification of research area gaps. Compared to inhalation toxicology, the literature available for dermal hazard assessment of nanomaterials is relatively low, with even fewer ingestion hazard studies. For the inhalation toxicology data, this includes both local effects in the lung as well as systemic effects, while the endpoints investigated focus on cytotoxicity, inflammation, oxidative stress or carcinogenicity, with relatively few on fibrosis or genotoxicity. With respect to nanomaterial physicochemical properties, the majority of studies focus on the influence of size in inducing pulmonary hazard, rather than charge, aspect ratio, solubility or crystallinity. A similar pattern is observed for the dermal studies. For each route of exposure, a much greater proportion are specifically related to in vivo studies, with less than 50% directly associated with in vitro studies. This data clearly demonstrates a need to expand research into ingestion and to relate a wider array of physicochemical characteristics to their hazard potential.

**Useful Approaches to Evaluating Adversary Behavior in National Security Risk Assessment**

The biggest weakness and source of uncertainty in national security risk assessments that incorporate scenarios of terrorist attack is estimating the likelihood and behavior of the adversaries who may commit such acts. However, prioritization decisions for security, prevention, or mitigation capabilities require some understanding of what an adversary may do. And higher level decisions require comparison of the likelihood of adversarial events with natural hazards and major accidents. This presentation discusses best practices and approaches for characterizing and assessing adversary behavior and likelihood. The talk will discuss identifying which adversaries or groups of adversaries to assess by categorizing with respect to intent (by type of group) and capability (by grouping into relevant levels). We will discuss adversary decision making (Optimizing? Satisficing?) as well as discussing opportunistic versus planned attack approaches. Adversary independent assessment approaches such as attack difficulty will be described. The talk will finish with a discussion of what type of results may be expected from using these approaches and how uncertainty and sensitivity may be communicated as well as how the rigor of the approaches may also be communicated to decision makers.

**Regulation vs. Risk of Agricultural Biotechnology in New Zealand**

In New Zealand, the Hazardous Substances and New Organisms (HSNO) Act (1998) regulates the introduction of organisms that are new to New Zealand primarily to prevent the introduction of organisms (GMOs) were particularly controversial when the Act was drafted, so GMOs were also classified as new organisms. The HSNO Act defines a GMO an as organism created using in vitro techniques. However, certain techniques that were commonly in use in breeding before the HSNO Act are specifically exempted from regulation. Thus, NZ EPA’s regulatory oversight of the introduction of a biotech organism for intentional release into the environment is dependent on its “new organism” status, as determined by the technology used to create it. Thus, plant varieties and animal breeds that were created using “traditional” (and essentially random) biotechnologies, such as radiation mutagenesis, embryo rescue and somatic cell fusion, are specifically exempted from regulation as new organisms, and any trait-based risks of such organisms are not considered. Recently a ruling by the New Zealand High Court quashed an NZ EPA determination that the new breeding technologies ZFN-1 and TALENs (types of so-called “genome editing” technologies), are substantially similar to chemical mutagenesis and their applications do not constitute the creation of GMOs. The High Court also ruled that the list of techniques exempted from regulation was exhaustive, rather than a list of examples, throwing into question the regulatory status of some techniques that had been assumed to be exempt. The High Court ruling prompted a review of breeding technologies by governmental agencies, including the NZ EPA. Examination of these technologies and the changes they create suggests that regulating organisms based on the technique used to create them results in regulation of the wrong end of the risk spectrum, at least as it pertains to the ability to assess the risk.
Case Study of a Combined Approach for Estimating Lung Cancer Risks Related to Smoking and Asbestos Exposure

Different factors influence lung cancer risk in populations and individuals. In this presentation, different risk factors and estimations discussed during the symposium will be presented relative to how they may be combined or contrasted to develop aggregate or individual risk comparisons and calculations. A case study will be utilized to provide a practical primer on how individual asbestos and smoking lung cancer risks and other potential contributors can be compared and contrasted to estimate overall standardized relative risk of lung cancer, allowing ranking of various risk factors. Application of various resources to perform such evaluations will be demonstrated. Finally, separate modes of risk interactions will be demonstrated from mathematical and/or toxicological points of view.

Cancer Risks Related to Smoking and Asbestos Exposure

Strode, R.; Chemistry & Industrial Hygiene, Inc.; RStrode@c-ih.com

Methodology for the Quantification of Dermal Contact with Water at Recreational Beaches Using Videography

When contaminants are released into the ocean through natural or man-made disasters, risk to public health from exposure to water borne contaminants on public beaches.

Stuchal, LD*; Roberts, CB; Denslow, ND; Roberts, SM; Center for Environmental and Human Toxicology, University of Florida and College of Public Health and Health Professions, University of Florida; lstuchal@ufl.edu

Application of Quantitative Decision Analytics in Nanotechnology

Our understanding of the environmental and health risks from nanotechnologies is still limited, which may result in stagnation of innovation, technological and economic growth, as well as potential unintended environmental and health damage due to their market-wide distribution. In response to the knowledge gaps and uncertainties currently associated with the Risk Assessment (RA) of NMs, decision analytic approaches offer a systematic approach to structure and analyse these complex problems in order to facilitate near-term regulatory decisions. Some relevant approaches include Multi Criteria Decision Analysis based methods (i.e. Multi Attribute Utility Theory, Multi Attribute Value Theory, Analytical Hierarchy Process and Outranking), Bayesian Networks, Value of Information and Comparative Life Cycle Analysis. The goal of this research is to critically review quantitative decision analytic approaches applied to nanotechnology in order to understand how they address knowledge gaps and uncertainties associated with it. The empirical literature obtained from our search was limited and diverse, but highlighted some key features that should be part of decision analytic approach to nanotechnology: i.e. quantitative approach, methodological integration (when required) and uncertainty estimation. Integration of methods can better guide nanotechnology risk management prescriptions and future research agenda. Some examples of methodological integration in the literature include MCDA and LCA, MCDA and Vol and MCDA with existing liability regulation. Uncertainty estimation in the nanotechnology context has been used not just to test the reliability of the decision model, but to make sense of conflicting data, data obtained in various experimental models, data on various end points, statistical artifacts and human error.

Subramanian, V; Semenzin, E; Hristozov, D*; Linkov, I; Marcomini, A; University Ca’ Foscari Venice; danail.hristozov@unive.it

Forecasting a definitive future with global warming widens the partisan divide regarding existence beliefs

When the Intergovernmental Panel on Climate Change (IPCC) reported a draft summary of the United Nations climate report based on scientific findings in Summer 2013 (IPCC, 2013a), the IPCC’s press release highlighted that the panel says they are near certain that global warming—and its anthropogenic cause—is real (IPCC, 2013b). While underscoring such certainty, the news media focused more on forecasting future consequences of global warming than documenting its past results. For instance, news coverage of the IPCC report stressed: “[s]ea level could be expected to rise at least 21 inches by 2100 and might increase a bit more than three feet (Borenstein, 2013).” Indeed, a recent content analysis of U.S. network news broadcasts between 2005 and 2011 showed that the common focus was on future, as opposed to past, impacts of global warming occurring in the United States (Hart & Feldman, 2014). Taken together, the state of the art of climate communication tends to put an emphasis on the future timing of consequences with near certainty about global warming. Telling the public about a future with global warming while highlighting certainty seems intuitively persuasive in establishing people’s existence beliefs because people may be worrying about the doomed future more than the unalterable past that has left them intact. However, cumulative evidence in psychological science calls for revisiting such an intuition (Van Boven, Kane, & McGraw, 2009). With a phone-based national survey experiment, here we predicted and found evidence that forecasting a definite future with global warming leads to widening the partisan divide regarding existence beliefs in global warming by lowering those of Republicans.

W3-F.3 Sungjong Roh, SR*; Jonathon P. Schultz, JPS; Cornell University; sr767@cornell.edu

P.164 Subramanian, V; Semenzin, E; Hristozov, D*; Linkov, I; Marcomini, A; University Ca’ Foscari Venice; danail.hristozov@unive.it

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Shooting, fast and slow: How gun-crime duration affects support for gun policy reforms

How might learning that a gunman carried out a mass shooting quickly versus slowly affect public support for gun policy reforms? We find that either duration can increase support depending on whether a lay theory of risk or moral responsibility is currently brought to mind (i.e., fast crimes imply greater risk, slow crimes imply greater blame). In a between-subjects experiment, participants (N = 195) read a mock news article about a gunman who killed numerous shopping mall patrons either quickly (in 5 minutes) or slowly (in 50 minutes). Immediately before reporting their support for stricter gun laws, participants were primed to consider either risk or blame through a question order manipulation. Results revealed a significant interaction between duration information and question order, such that the fast crime engendered more support for gun reforms when participants were risk-primed, whereas the slow crime engendered more support when participants were blame-primed. Amid continuing news reports of mass shootings in America, the effect of gun-crime duration information on support for gun policy reforms may not be context-free but instead constrained by how that information is likely to be applied under currently activated cognitive schemas (Higgins, 1996). Thus, these results carry practical implications for those seeking to shape public opinion in the gun debate: whereas messages that stress duration information that aligns with risk or blame considerations of risk amid news of quickly-unfolding gun crimes, opponents may wish to emphasize considerations of moral responsibility.

Examining relative potencies of chemical mixture components from in vivo studies using Benchmark Dose Software

Bliss (1939) defines chemical dose additivity as a consequence of “similar joint action,” such that chemicals behave as dilutions of one another. This definition of additive potencies allows that doses resulting in the same magnitude of response will be proportional across the response range (“constant relative potency”) and, consequently, that the shapes of the chemicals’ dose-response (DR) curves will be the same. In the context of chemical mixture risk assessment, constant relative potency means that doses scaled by relative potency factors (RPFs) can be added to determine the mixture response. Dose additivity need not be apparent based on administered dose, because constant proportionality is associated with delivered dose rather than with administered dose. The shapes of administered-DR curves for compounds known to be acting by the same mechanism of action may not be the same if there are dose-dependent differences in toxicokinetics, or dose-dependent changes in the mode of action. Thus, the shapes of modeled curves using administered dose data cannot define whether two or more compounds are dose-additive. Evidence of similarity of toxic action is the primary criterion for deciding whether to group chemicals using relative potency factor (RPF) approaches. RPFs can be estimated from DR modeling results, e.g., EPA’s Benchmark Dose modeling software (BMDS). There are a number of existing methods for estimating RPFs and evaluating chemical mixture risk. We primarily address using BMDS modeling results to derive RPF estimates and to evaluate dose additivity for chemicals exhibiting similarity of toxic action, describing the BMDS model parameters that define proportionality and relative potency. Example RPF calculations are presented based on similar and dissimilar DR curve shapes for both dichotomous and continuous endpoints. Applications of RPFs from dissimilar DR curve shapes, particularly for continuous endpoints with different response limits, are highlighted.
Information imperfection assessment in decision-aiding methods: application to risk management in mountain areas

In mountain areas, natural phenomena such as snow avalanches, debris-flows and rock-falls, put people and objects at risk with sometimes dramatic consequences. Risk is classically considered as a combination of hazard, the combination of the intensity and frequency of the phenomenon, and vulnerability which corresponds to the consequences of the phenomenon on exposed people and material assets. Risk management consists in identifying the risk level as well as choosing the best strategies for risk prevention, i.e. mitigation. In the context of natural phenomena in mountainous areas, technical and scientific knowledge is often lacking. Risk management decisions are therefore based on imperfect information. This information comes from more or less reliable sources ranging from historical data, expert assessments, numerical simulations etc. Finally, risk management decisions are the result of complex knowledge management and reasoning processes. Tracing the information and propagating inaccuracy from data acquisition to decisions are therefore important steps in the decision-making process. A global integrated framework is proposed to improve the risk management process in a context of information imperfection provided by more or less reliable sources. It includes uncertainty as well as imprecision, inconsistency and incompleteness. It is original in the methods used and their association: sequential decision context description, development of specific decision-making methods, imperfect propagation in numerical modeling and information fusion. This framework not only assists in decision-making but also traces the process and evaluates the impact of information quality on decision-making. However, consideration of imperfect information in the expertise process generates questions and paradoxes: how and how far should we finally communicate about the information imperfections to really help rather than complicate decisions?

A Spatiotemporal Informatics Framework for Modeling Dengue Fever Risk

Increasing climatic extremes have caused growing concerns about the health effects and disease outbreaks. The association between climate variation and the occurrence of epidemic diseases play an important role on a country’s public health systems. Part of the impacts are direct casualties associated with the increasing frequency and intensity of typhoons, the proliferation of disease vectors and the short-term increase of clinic visits on gastro-intestinal discomforts, diarrhea, dermatosis, or psychological trauma. Other impacts come indirectly from the influence of disasters on the ecological and socio-economic systems, including the changes of air/water quality, living environment and employment condition. Previous risk assessment studies on dengue fever focus mostly on climatic and non-climatic factors and their association with vectors’ reproducing pattern. The public-health implication may appear simple. Considering the seasonal changes and regional differences, however, the causality of the impacts is full of uncertainties. Without further investigation, the underlying dengue fever risk dynamics may not be assessed accurately. The objective of this study is to develop an epistemic framework for assessing dynamic dengue fever risk across space and time. The proposed framework integrates cross-departmental data, including public-health databases, precipitation data over time and various socio-economic data. We explore public-health issues induced by typhoon through literature review and spatiotemporal analytic techniques on public health databases. From those data, we identify relevant variables and possible causal relationships, and their spatiotemporal patterns derived from our proposed spatiotemporal techniques. Eventually, we create a spatiotemporal causal network and a framework for modeling dynamic dengue fever risk.

Taking advantage of diffusion effects in a network to increase effectiveness of risk communication

The effective communication of risk faces multiple obstacles fueled by several factors such as misperceptions of the exposed population or distrust of the institutions in charge of the communication. The overestimation of risks in a community can lead to the wasteful or counterproductive behavior intended to reduce the perceived risk. In this paper a model using social network tools is introduced to analyze the effectiveness of different risk communication strategies under budget constraints. When the structure of the network describing the links between the members in a community is at least partially known, diffusion effects can be exploited to more effectively communicate about a risk and the ways it may be mitigated. By directing communication to specific targets, the benefits of more accurate risk perceptions can arrive faster than in a generalized random communication framework. The models is illustrated by an application to the health risks of consuming tap water in Nogales, AZ.
M3-D.3 Tambe, M*; US Coast Guard; nathan.w.allen@uscg.mil

US Coast Guard perspective on protecting fisheries

of wildlife, fishery poaching, and improving anti-poaching security strategies

Game Theory in the Field: Evaluation of Deployed Decision Aids

Our research has led to decision aids used on a daily basis by security agencies such as the US Coast Guard, Federal Air Marshals Service, LAX police, LA Sheriff’s Department and others for scheduling daily security activities such as randomized patrols, assignment of checkpoints, and so on. These decision aids are also being adopted by security agencies in other countries, including Singapore Police Force and by agencies interested in protecting wildlife in Africa. These decision aids are based on game theory and in particular Stackelberg games, and allow us to measure the impact of game theory in the field. The goal of this presentation is to report on actual results of game theory being used in the field. We will report on experiments performed in the field in service of measuring this impact. For example, we discuss the results of a real-world experiment that aims to evaluate the comprehensive game-theoretic system built to capture fare evaders on metro trains in Los Angeles: we ran a 21-day experiment, where we compared schedules generated using our approach against competing schedules comprised of a random scheduler augmented with human knowledge, and showed the benefits of the game theoretic scheduler. In this case, the game theoretic scheduler was shown to capture more fare evaders and the result was statistically significant. We will also discuss results of field experiments in Uganda of patrols used for protecting wildlife (in the Queen Elizabeth National Park) and patrols in the Gulf of Mexico (done by the US Coast Guard) to protect fisheries from illegal fishing.

M3-D.4 Tambe, Milind*; Ford, Benjamin; Nguyen, Thanh; Lemeiux, Andrew; University of Southern California; tambe@usc.edu

Decision aids for protecting wildlife and fisheries: Using algorithmic and behavioral game theory

Protection of wildlife and fisheries are major international challenges facing humanity that demands an intelligent response. Turning to wildlife, tigers, along with many other endangered species, are in danger of extinction from poaching; the global population of tigers has dropped over 95% from the start of the 1900s. With respect to fisheries, in areas such as the Gulf of Mexico, illegal, unreported, and unregulated (IUU) fishing seriously threatens the health of local fish stocks. We have built software decision aids for agencies faced with the challenge of protecting wildlife and fisheries, to assist them in allocating their limited security resources. These decision aids are based on the framework of Stackelberg security games, and result in providing advice on where and when to patrol, generating randomized patrol patterns informed by observed illegal activities and locations of wildlife (or fish) density. Common to the decision aids we have built, e.g., for the US Coast Guard for deployment in the Gulf of Mexico, is their basis in a unique combination of computational game theory with models of human behavior learned from data of illegal activities. This learning of human behavioral models, and repeated interaction with adversaries sets this work apart from previous work in applying game theory for security applications.

W1-C.1 Tano, MT; International Institute for Indigenous Resource Management; mervtano@iiirm.org

Managing Risks to Climate-Threatened Cultural Landscapes of Indigenous Peoples

The view that climate change impacts pose a direct threat to indigenous societies because of their reliance on resource-based livelihoods is prevalent in much of the works by the United Nations University, Intergovernmental Panel on Climate Change, Secretariat of the Convention on Biological Diversity, United Nations Development Programme, and United Nations Educational, Scientific and Cultural Organization (UNESCO). This presentation examines these characterizations of climate vulnerabilities of indigenous peoples and suggests that adaptive management policies, plans, research, and programs undertaken by international organizations, NGOs, governments, and corporations based on these characterizations may prove inadequate, ill-adapted, and even inimical to the myriad interests of indigenous peoples. Defining traditional knowledge as a compendium of factoids, is, at the very least, condescending and at its worst neocolonial—especially as has happened in the recent past, traditional knowledge is mined for agricultural, medicinal, and land and other resource management technologies that can be integrated into Western climate adaptation strategies. Managing risks to cultural landscapes requires both the development of traditional knowledge holders and the evolution of the systems and institutions in which they can operate.
Graph Theoretic Approaches

Exploring the Resilience of the US Aviation Sector via

The US Department of Homeland Security identifies a list of 16 critical infrastructure sectors (CIS). Given the critical role of the CIS to the US economy and their high interconnectedness with one another as well as with other sectors, ensuring the security of the network and infrastructure vulnerabilities and resilience. One of the essential critical infrastructures is the US aviation sector. CIS are complex adaptive systems with many interconnections and interdependencies and exhibit emergent properties. Central to developing resilient CIS is gaining an understanding of the interconnectedness and interdependencies between CIS including feedback loops. Such understanding is critical for identifying systemic vulnerabilities and resilient design. Graph theory-based methods have been extensively applied to understand the structure and behavior of networks. However, they remain largely unexplored for understanding the resilience of CIS and evaluating sustainability in the existing literature. A graph theoretic framework is utilized to study the network structure and topology of the US aviation sector. The US aviation sector is modeled as directed, weighted graph with passenger flows between pair of airports representing the weights. A variety of network and node level metrics are developed and estimated to analyze the structure of the US aviation sector. A robustness analysis will be performed in response to random and targeted attacks of the nodes. We compare and contrast the network topology and efficiency of the original network with the disrupted network to gain insights about the critical nodes in the network. Several different clustering and community detection algorithms are utilized to help uncover the pattern of connections and aid in understanding the cascading impact of disruptions and resilience implications in the US aviation network. The implications of the results for developing risk management strategies and guiding the resilient operation of the network will also be described.

The Application of Chemical Dispersion Models to Indoor and Outdoor Populations

The release of a toxic, explosive, or flammable chemical from a storage container, initiated by either adversarial actions or safety hazards, could result in environmental and economic consequences as well as considerable loss of life. ABS Consulting supports the Department of Homeland Security and the United States Coast Guard in assessing the risk of chemical releases from industrial facilities, vessels, barges, and railcars. These risk assessments aid in the development of policies, regulations, and strategies which aim to mitigate the risk of release and protect the public. Effects on populations exposed to toxic vapor clouds or explosion blasts are different for indoor versus outdoor populations. For toxic releases, populations indoors are generally exposed to lower concentrations because vapors must infiltrate the building. For explosion blast exposure, life-threatening injury mechanisms tend to be very different for indoor and outdoor populations. To improve the accuracy of these chemical release-based fatality estimates, ABS Consulting has recently enhanced the chemical dispersion tool to account for indoor and outdoor populations. Since a majority of people are generally inside at a given time, this enhancement provided a major increase in the accuracy of fatality estimates. To determine the effects of a chemical release on indoor and outdoor populations, ABS had to consider (1) the percentage of population indoor vs. outdoor, (2) the air exchange rate between outside and inside of a structure, and (3) the toxicity of the chemical or effects of resultant explosion. These factors were used to develop an enhanced, more accurate representation of chemical dispersion consequences which are used to impact national-level risk mitigation policy, regulation, and strategy.

Considerations for Analyzing Risks Posed by Mixtures of Phthalates

Environmental risk assessment approaches are needed to evaluate human health risks from exposures to phthalate mixtures via multiple routes and pathways. The primary toxicological health effect is disturbance of androgen action which manifests itself in a variety of altered male reproductive development outcomes in rats, leading to a concern for similar health effects to occur in humans. This common key event supports use of a dose addition method but the risk assessment is fraught with difficulties. To conduct an assessment, tasks include forming chemical groups based on similarity of toxic action, choosing endpoint(s) on which to base the assessment, accounting for multiple route/pathway exposures, developing reference values or relative potency factors (RPFs) based on various points of departure and endpoints, and evaluating phthalates among which the amount of toxicity data available are highly variable. This presentation proposes an approach to the cumulative risk assessment of phthalates by developing a range of RPFs for each phthalate and applying a cumulative RPF methodology. Such an approach allows for grouping by similarity of toxic action, decreases the number of phthalates being subjected to dose addition, considers all data sets of good quality, and includes phthalates with limited data. The theoretical basis for the method is presented along with a practical example.
Real-world chemical mixtures in ambient groundwater of the United States

M3-H.3 Toccalino, PL*; Norman, JE; Skach, KA; U.S. Geological Survey; ptocca@usgs.gov

Many investigators have stressed the importance of evaluating the toxicity of real-world chemical mixtures identified in the environment and at environmentally relevant concentrations. In a relatively few examples, however, ambient groundwater data that have been used in chemical mixtures research. The U.S. Geological Survey (USGS) evaluated chemical mixtures as part of two recent large-scale studies of ambient groundwater used as sources of drinking water. In the first study, chemical mixtures were assessed across several inorganic and organic chemical classes in samples from 383 public-supply wells located in 35 states. The second study assessed mixtures of pesticide compounds in samples from 1,271 domestic, public, and monitoring wells in 37 states. Using new USGS software for the analysis of chemical mixtures, we (1) assessed the occurrence of chemical mixtures, (2) determined the composition of the most frequently occurring mixtures, and (3) compared concentrations of mixture components to human-health benchmarks as a screening tool for potential toxicity. In the first (public-well) study, most samples (84%) contained mixtures of two or more compounds, each at concentrations greater than one-tenth of individual benchmarks. The most common mixtures at these concentrations primarily were composed of trace elements (including selenium, molybdenum, and arsenic). In the second (pesticide) study, nearly 40% of samples contained two or more pesticide compounds, but <1% contained mixtures of pesticides at concentrations greater than one-tenth of individual benchmarks. Atrazine, deethylatrazine, simazine, metolachlor, and prometon were common components of pesticide mixtures. Identifying all possible chemical mixtures in sources of drinking water and assessing their toxicity is not practical, but our findings can help to identify which chemical mixtures may be of most concern based on detection frequencies and comparisons to benchmarks.

M4-I.3 Torres, CW*; ENVIRON International Corporation; ctorres@environcorp.com

Reconstructing exposures for the semiconductor industry to assess risks of hematological malignancies

A retrospective exposure reconstruction study was conducted to determine exposure profiles for three historical semiconductor manufacturing lines. Exposures to non-carcinogenic elements, including Ni, Cu, Co, and Sn, were characterized. Exposures were assumed and therefore characterized in two instances. First, exposure was assumed for any process area in which a Group 1 human carcinogen recognized to cause leukemia was used in the process or was potentially present as a by-product. Second, exposure was considered likely in a process area in which a Group 2 (probable or possible human) carcinogen was measured at or above 50% of the related occupational exposure limit (OEL). Characterized exposures in 35 similar exposure groups (SEGs), reconstructed exposures for the three lines using qualitative risk assessments (QLRAs), quantitative industrial hygiene exposure monitoring data and Bayesian statistics. With regard to a historical and now obsolete process, we also modeled exposures using 2-zone, near field/far field techniques. We combined the exposure profiles with time, frequency, and employment durations to reconstruct doses. We compared the reconstructed average and cumulative exposures with exposures reported in epidemiological studies for the purpose of estimating risk. We formed a number of opinions and drew a number of conclusions: Reconstructed exposures yield dose calculations which were generally higher than observed, and exposure levels were below the level of detection for over 90% of the measured elements. Lifetime risk estimates were within the range of acceptable excess lifetime risks (a range between 1x10^-6 and 1x10^-4) for the general population. High quality exposure assessments are required for health studies where exposure data are largely censored.

P28 Tosoni, E*; Cadini, F; Zio, E; Politecnico Di Milano; edoardo.tosoni@yahoo.com

Continuous-time particle tracking for modeling the migration of 90Sr released from superficial nuclear disposal facilities

In this work we address the problem of modeling the release and transport of 90Sr in groundwater from a superficial spent fuel disposal facility. In order to evaluate the impact of the potential migration of 90Sr to the aquifer, we have implemented a continuous-time Monte Carlo particle tracking algorithm, and a semi-empirical model for capturing the effect of the seasonally varying water table on the 90Sr concentrations. The model calibration is achieved by resorting to the Genetic Algorithms to minimize the mean squared error between the estimated concentrations and those observed at a well used by the local environmental agency to monitor the 90Sr plume evolution. Via a relationship recommended by the ICRP, the 90Sr concentrations predicted by the model are used to predict the annual committed effective dose to a reasonably maximally exposed individual due to contaminated water consumption. All the potential sources of uncertainty of the modelization are quantified and then represented by means of suitable probability density functions of the main model parameters, so that they can be propagated to the predicted dose, whose unknown distribution is thus estimated. Hence risk curves representing the time-dependent predicted probability that the dose exceeds a given threshold are obtained. In this way, a high probability of exceeding the annual committed effective dose is obtained, showing, in particular, a high probability of exceeding the no-radioactivity-relevance limit of 10 &#61549;Sv. Overall, the model developed proved to be a satisfactory compromise between precision in predicting the 90Sr concentrations, which is aimed at performing the dose assessment, and computational speed, which allowed to perform the uncertainty analysis in about 36 hours on an Intel Dual Core Processor @2.20 GHz.
M3-K.3 Towler, EL*; Lazrus, H; PaiMazumder, D; National Center for Atmospheric Research; towler@ucar.edu

Interdisciplinary approach to drought risks in the context of social, political and climate change

Traditional drought research has mainly focused on physical drought risks and less on the cultural processes that also contribute to how drought risks are perceived and managed. However, as society becomes more vulnerable to drought and climate change threatens to increase water scarcity, it is clear that drought research would benefit from a more interdisciplinary approach. To inform palatable policy options, drought risk needs to be assessed in the context of both climate prediction as well as improved understanding of socio-cultural processes. To this end, this study explores a risk-based framework to combine physical drought likelihoods with perceived social risks from stakeholder interviews to develop a Combined Drought Risk Matrix (CDRM). The CDRM characterizes drought risks as the products of both physical and social processes, thereby also reflecting local stakeholders’ preferences for water management. Results are presented from a case study on how stakeholders in south-central Oklahoma perceive drought risks given diverse cultural beliefs, water uses, and uncertainties in future drought prediction. Stakeholder interviews (n=38) were conducted in 2012 to understand drought risks to various uses of water, as well as to measure worldviews from the cultural theory of risk – a theory that explains why people perceive risks differently, potentially leading to conflict over management decisions. Drought likelihoods are derived from Global Climate Model scenarios, which indicate that drought probability is likely to increase in future. Analysis of interviews shows that there is consensus on the risks to some water uses (e.g., drinking water), but significant variability on other water uses (e.g., recreation). Variability in risk perceptions is partially explained by the cultural theory of risk. Our analysis shows that the greater the range of risk perceptions about a particular water use, the more sensitive the combined risk is to changes in physical drought.

P.98 Trumbo, CW*; Kim, S; Colorado State University; ctrumbo@mac.com

Antecedents to Electronic Cigarette Use

Concern has been growing over the use of electronic cigarettes. CDC reported doubling of e-cigarette use among high school students from 2011-2012 (1.78 million having tried e-cigarettes in 2012). Other studies have reported that 71% of college students to have heard of e-cigarettes and 13% had tried them. In the population of young adults there is evidence that e-cigarettes are providing a path to nicotine dependence and possibly uptake smoking. It is therefore important to evaluate the antecedents for their use. This investigation was grounded in three theoretical perspectives: the Theory of Reasoned Action, the Heuristic-Systematic Model, and cognitive-affective risk perception. The latter is interesting since risk perception has been used to investigate smoking as well as technologies, with e-cigarettes possessing both characteristics. This suite of concepts has not previously been used to examine use of e-cigarettes. Multi-item measures were used for each concept with good to excellent reliabilities. Data collection was accomplished in fall 2013 using an online survey presented as an extra credit activity in an undergraduate large lecture class serving a broad cross-section of students on campus. Of the 398 students enrolled in the course, 309 completed the survey (78%). After removal of incomplete cases 296 cases were available for analysis. A hierarchical linear regression model was used for initial analysis, showing that attitude-toward-act and perceive social norms both significantly predict behavioral intention, that systematic processing further improved the model (heuristic only significant at p < .1), and that both affective and cognitive risk perception further improved the model (R2 = .21). Adding control for smoking status and having tried e-cigarettes further improved the model (R2 = .44). The configuration of the model indicates that a structural model will best highlight the system of relationships, and this approach will be employed in the final analysis.

M3-K.2 Trumbo, CW*; Marlatt, HL; Colorado State University; ctrumbo@mac.com

Climate Change, Weather, and Perception of the Risk Time Horizon

We used mail survey methods to study a panel of individuals located in the Southeast and Gulf coastal area of the U.S. Study participants were sampled in a spatially random manner within a 10-mile buffer along the coast. The same individuals were surveyed three times at one-year intervals (2010-12). The initial response rate was 56%, with panel continuation rates of 75% and 85%, yielding a sample size ranging from approximately 650 to 350 depending on configuration. In this analysis we use the 2011 and 2012 data (analysis n = 350) to focus on a subset of variables that relate to perception of changes in the weather, past experience with hurricanes, and orientation toward climate change. Because the emerging narrative on climate is emphasizing the immediacy of the threat we especially focus on whether respondents report thinking that changes on climate are happening now or are off in the future. Within our analysis we find that perception of greater immediacy for climate change impacts is significantly associated with reporting greater exposure to the message that Hurricane Sandy was intensified by climate change (r = .21), reporting a perception of increasing local air (r = .16) and ocean (r = .23) temperatures over the past year or so, motivation for being informed about the relationship between climate and hurricanes (r = .33), and several risk perception indicators for climate as well as hurricanes (full model R2adj = .41 p < .001). Taken together, our findings may lend support to a recently emerging communication strategy in which climate change is being increasingly linked to specific extreme events as well as overall warming-related shifts in weather conditions. And perhaps more important, to the argument that climate change is now observable and not a hypothetical threat in the distant future. A shift in the time horizon for the communication and public perception of climate change risk could form a basis for important social change on this critical problem.
Overseas Piracy

Since the initiation of overseas trade, there has always stood the threat of piracy. Although story tellers and media sources may have made it a glorified profession, and individuals such as Edward Teach, otherwise known as Blackbeard, are made in some cases out to be heroes, the piracy issue has become as prominent and deadly as ever, without garnering much notice. With their fully automatic machine guns and rocket propelled grenade launchers, these insurgents have taken to the high seas and have plagued some of modern day’s busiest maritime pathways, including places like the Strait of Malacca and the seas of Southeast Asia, the Gulf of Aden, and the Horn of Africa. From coming aboard ships at sea or when docked, these acts have cost international traders, private parties, cruise liners, etc. cargo, money, and in a lot of unfortunate cases, lives. There are several factors that not only welcome, but sometimes encourage piracy. Factors such as developed nature of the country, the current governmental status and their enforcement (or lack thereof) of maritime piracy, or even the financial climate of the area that the insurgents are in can play a great role. This presentation will delve into discussing many of these factors and targeting where the most notorious spots for such events have occurred, are occurring, and will happen in the near and distant future.

Social capital and disaster preparing behaviors and perception in the US

Influence of social capital on Disaster-Preparedness in Neighborhood and Self-Preparing Behaviors against Disasters in individuals was analyzed. Putnam (1995, 2000) defined the concept of social capital as social network and also focused on its psychological aspects of trust, good will, fellowship, and sympathy. We conducted nationwide online survey in the US about risk perception and preparing behaviors against disasters [N=830] in the fall 2011. In the US about 70% of firefighters are volunteers (National Fire Department Census Database, FEMA). We used the ratio of fire departments with volunteer-firefighter as an index of social capital against disasters. The respondents [N=231] in 18 States (Minnesota, Pennsylvania, Vermont, New York, etc.) of volunteer-firefighter [Departments with mostly volunteer firefighters > 90%] and the respondents [N=163] in 5 States (Florida, Massachusetts, California, etc.) of career-firefighter [Departments with mostly career firefighters > 40%] were analyzed. The results showed that in the States of volunteer-firefighter Subjective Connectedness with Neighbors strongly determined Neighborhood Efficacy against Disasters, while in the States of career-firefighter Community Activities, Subjective Connectedness with Neighbors, and Perceived Disaster-Preparedness in Neighborhood were important. A model with Neighborhood Efficacy against Disasters, and Subjective Connectedness with Neighbors decreased Self-Preparing Behaviors against Disasters. It would be interpreted that in the States of volunteer-firefighter people would expect neighborhood cooperation against disasters as social capital, and individual difference of subjective connectedness with neighbors was not correlated with the perception of preparing behaviors against disasters. In the States of career-firefighter, on the other hand, subjective connectedness with neighbors was correlated with personal disaster preparing behaviors.

Risk of Synthetic Biology and Nanotechnology for Environmental Remediation: Integrating Data and Judgment

Emerging technologies present significant challenges due to a lack of quantitative risk, benefit, and cost data associated with their use. We interview top scientists who score technology performance and weight criteria importance in a decision-analytic framework integrating evidence-based data with expert judgment to evaluate three environmental remediation technologies. Results favor synthetic biology over nanotechnology and conventional methods in terms of expected future benefits and deployment cost but prefer conventional technology for reduced risks and development cost.

Taking a Risk: Using Clustering to Prioritize Literature Search Results

Systematic review of the literature for risk assessment purposes can result in > 10,000 references, which can be time and cost intensive to review in a traditional linear manner. The risk of missing an important reference in the review of the literature results must be balanced with the time and effort required. Clustering references from large databases has been used as an effective tool to identify relevant literature more efficiently. Commercially available, visual analytics software enables clustering of similar references based on automated text analysis of the title, keywords, and abstract. References are clustered around key concepts that distinguish papers from the full set of results; one or more clusters representing specific concepts can then be selected for review. We asked how clustering compared to a traditional keyword search in terms of number of references to review and efficacy at identifying highly relevant literature. We searched for a specific concept (i.e., susceptibility to arsenic exposure) within a comprehensive database of arsenic literature containing approximately 35,000 references to compare the results from keyword searches and multiple clustering techniques. Our keyword search yielded approximately 3,500 results. We identified an additional 780 references from forward and backward supplemental searches of key review papers. All references from the keyword and supplemental search were screened for relevance to arsenic susceptibility. We compared these “traditional” results with results from different clustering techniques to determine which approach captured the highest percentage of relevant references while minimizing the number of false positives.
P.140 Turley, A*; Overton, R; Burch, D; Ross, P; Cleland, J; Henning, C; ICF International; audrey.turley@icfi.com

Evidence Integration for Systematic Review Made Easier with DRAGON

ICF International’s DRAGON is an online database platform and software tool designed to store and manage qualitative and quantitative data from scientific literature when conducting a systematic review. Completing a truly systematic review for a chemical risk assessment requires evaluation of human, animal, and in vitro studies to support a causal determination. After evaluating the quality and potential for bias of the studies, the risk assessor faces the challenge of integrating evidence from multiple “streams” to support conclusions. DRAGON is configured to help a risk assessor search, analyze, synthesize, and report chemical information accurately, efficiently, and transparently. Evidence integration is supported by DRAGON’s evergreen health effect list that facilitates consolidation of data across studies and streams of evidence for a common health effect or outcome. DRAGON also includes standardized fields for key study features that are common to studies of all types (such as route of exposure, chemical/metabolite, and exposure duration) and are important considerations for evidence integration. A straightforward database query identifies all studies of a particular health effect, and those studies can be further organized based on their characteristics. During this presentation, we demonstrate the application of DRAGON for a chemical risk assessment with a large literature database and show how DRAGON’s organizational structure and flexibility in application aid in the integration of evidence to answer the fundamental question, “Does chemical x cause this health effect?”

W4-F.7 Uebelherr, J; Arizona State University School of Public Affairs and Center for Policy Informatics; uebelherr@gmail.com

Climate Adaptation in Phoenix: Gap Analysis of Cooling Center Accessibility

Heat related mortality (HRM) is the leading cause of natural disaster deaths in the U.S., exceeding that of hurricanes, tornadoes, floods and lightning combined. Climate change is increasing the frequency and intensity of heat waves and the risk of HRM. Increased HRM from climate change falls disproportionately on vulnerable populations such as the very young, elderly, infirm, and lower socio-economic status without air conditioning (AC) access. An effective means of reducing HRM risk is access to AC during National Weather Service Excessive Heat Warnings (EHW). In 2013 a network of 27 Phoenix, AZ area organizations volunteered as cooling centers (CC) throughout the summer, with an additional 9 activated only during EHW. This public-private partnership provided ad-hoc spatial and temporal coverage, though there has been no systematic critical analysis of how this network meets public need. Phoenix area data shows an average increase of over six additional HRM events per year from 2001-2012 suggesting growing public need for CC. To assess this need, this study compared 2013 CC availability to hourly evening Heat Index (HI) 105°F exceedance (1988-2013) and an evaluation program instituted during 2014 in partnership with Arizona public health agencies. HI exceeded 105°F after 5pm a total of 602 hours from 1988-2013, 92% of which occurred from 5-7pm. Of the 36 CC, 89.4% closed before 5pm on weekdays and 11.1% closed after 5pm on weekdays, while on weekends 11.1% closed before 5pm and 8.3% remained open after 5pm. This analysis suggests that the majority of 2013 CC missed critical evening hours believed to be important for physiological recovery during EHW. Initial cooling center staff interviews indicate outreach efforts did not engage those without AC, a potential opportunity for intervention. These results indicate a need for increased CC temporal and spatial coverage, and outreach in vulnerable communities without AC.

W4-J.3 Ulmer, FU*; Raskob, WR; nop profit Organisation DIALOGIK; ulmer@dialogik-expert.de

SECURITY2People – Functionality of the Final Demonstrator

Within the German Security Research initiative, the integrated project SECURITY2People (Secure IT-Based Disaster Management System to Protect and Rescue People) aims at exploring the needs for and the structure of an integrated disaster management system that is applicable for all types of emergencies and at all levels of emergency management from the local to the Federal Government. Having started in mid 2009, the project will end November 2012. Based on modern IT-technology, a web portal with interconnected portlets has been designed. Portlets for functionalities such as Situation Awareness, Message Management, Knowledge Databases, Key Performance Indicators, Multi-criteria Analysis, Strategic Decision Support, Strategic Simulation, Action Force Management, Analysis and a Social Media Component have been designed for the final demonstrator. External components have been integrated via the Interoperability Platform of SECURITY2People.

W3-C.4 Tymchak, MP*; Flewelling, SA; Gradient; mtymchak@gradientcorp.com

Evaluating Induced Seismicity and Underground Injection Wells

Flowback and produced water generated from hydraulic fracturing and oil and gas production have led to increased disposal through underground injection wells. Larger disposal volumes and more injection wells can potentially affect the likelihood of inducing seismic events in some geological settings. Several studies have suggested recently felt seismic events may be associated with underground injection wells in Arkansas, Ohio, Texas and Oklahoma, among others. However, in some of these cases, the data are insufficient to determine with a high degree of certainty whether earthquakes were related to fluid injection or natural tectonic processes. In states or regions with many injection wells, nearly every seismic event (whether induced or natural) is near an injection well, further complicating efforts to differentiate natural from induced seismicity at these larger scales. Moreover, it is unclear why earthquakes have occurred near some injection wells but not others with apparently similar geology, target reservoirs, and injection rates. In this presentation, we explore approaches that can be used to distinguish between natural and induced seismic events and discuss the conditions under which induced seismicity can be more clearly identified. Understanding the controls on induced seismicity and the techniques required to diagnose its occurrence are necessary for evaluating the potential seismic risk associated with underground injection wells.

W3-F.1 Munch, J; Arizona State University; jmmunch@asu.edu

Vulnerability of Native American and Hispanic Communities to Extreme Heat Events

Native American and Hispanic communities have been disproportionately affected by extreme heat events. Arizona’s population is one of the most vulnerable to such events. This research documents the vulnerability of native American and Hispanic communities in Arizona to extreme heat events. The study focuses on the Navajo Nation, a large tribal reservation in the state and the second largest tribe in the USA. Data from the 2010 US Census are used to identify the native American and Hispanic populations and their exposure to extreme heat events. The results show that more than 60% of the Navajo Nation’s population is exposed to extreme heat events. The study also identifies the most vulnerable groups within the Native American and Hispanic populations and the potential solutions to reduce their exposure to extreme heat events.
W3-H.3 van Bemmel, DM; US Food and Drug Administration Center for Tobacco Products; dana.vanbemmel@fda.hhs.gov  
Division in Research to Support Tobacco Product Regulation  

Tobacco regulatory science is focused on informing the Food and Drug Administration, Center for Tobacco Products’ (FDA-CTP) regulatory authority over the manufacture, marketing, and distribution of tobacco products. FDA’s traditional “safe and effective” standard for evaluating drugs and other medical products does not apply to tobacco products, which are inherently unsafe. The Tobacco Control Act (TCA) established a new standard directing FDA-CTP to regulate tobacco products according to their impact on overall population health, including taking into account product users and nonusers and assessing the increased or decreased likelihood of product initiation, switching, multiple product use and cessation. Although a sound science base exists with regards to multiple areas related to the TCA, new research will provide additional science for FDA to consider as it implements the TCA. This presentation will provide an overview of what tobacco regulatory science is and is not using examples from FDA-CTP’s public health framework for tobacco product regulation, highlight studies in CTP’s broad portfolio of currently funded tobacco regulatory research, and discuss current and planned funding opportunities.

M2-B.1 van Ruijven, BJ; National Center for Atmospheric Research; vruijven@ucar.edu  
Using scenarios for analyzing future climate change impacts  


M3-B.5 Vareman, N; Sahlin, U; Lund University; niklas.vareman@cecm.lu.se  
What is the difference between risk-based, evidence-based and knowledge-based decision making?  

In the effort of producing procedures for well-reasoned, rational and therefore justifiable decisions the concepts of risk-based (RB), evidence-based (EB) and knowledge-based (KB) decision making have been introduced. They aim, in their separate ways, to capture essential aspects of the decision making process. But in what way do they differ? And what do they add to decision schemes based on classical normative decision theories? These three concepts see the decision making process a little differently. RB is concerned with the distinction between risk assessment and risk management, and the nature of information that the assessment provides the management with. EB is about how to find and use high quality evidence to weight decision alternatives, while KB is a more informal description of how to make group decisions where all stakeholders’ views are adhered to. But the three concepts also signal a kind of focus: A RB decision procedure is concerned with the thorough assessment of what is seen as risks and how this is handled by decision makers. An EB approach highlights the importance of basing decisions on proper scientific evidence. A KB decision making focuses on openness in order to bring different types of knowledge into the decision. Surely all these aspects are important for decision making. Question is whether they all are elements of every one of these approaches. In other words: will a risk-based decision procedure miss out on the use of scientific evidence, or on openness? Will an evidence-based approach lack the proper handling of risks and openness? Will the knowledge-based decision making downplay risks and evidence? We will in this presentation analyse the different concepts in order to bring out some clarity to what they want to capture.

P.152 Verteramo Chiu, LJ; Turvey, CG; Cornell University; ljv9@cornell.edu  
Perception and Action in a Conflict Zone: A Study of Rural Economy and Rural Life amidst Narcos in Eastern San Luis Potosi, Mexico. This is the title  

The level of violence in Mexico caused by the ongoing war on drugs has escalated dramatically in scale and scope affecting all members of Mexican society in many parts of the country. Despite this, little has been investigated on how drug violence impacts the human psyche, the changes in risk perception, or how it affects life in general. This paper analyses the response to drug violence of small scale Mexican farmers. For this, we used the approach to behavior based on the dual process theory. This analysis was conducted in a conflict zone between drug cartels where most of the population have experienced or have been affected by drug violence. We found various significant factors that explain fear among farmers, and how that fear is affecting rural life and production decisions. In this analysis, using a variety of established psychometric models to determine degree of fear (Slovic, 1987) we created four groups that classify people according to their attitudes toward fear, and then analyze the effect of demographic and economic variables in determining group membership and on actions/intentions in response to fear. Following the dual process theory and stimulating the emotional and deliberative systems of decision making, we find that for all groups the emotional mechanism (system 1) have a larger effect than the rational mechanism in making life changing decisions. On the other hand, people with higher rational assessment of risk (system 2) are more likely to change production decisions. Our results provide some bases for new directions of study on risk perception and decision making process. By understanding farmers’ response to violence, responses to mitigate fear due the stigma of drug violence can be implemented, as well as strategies for adopting new technology in small scale farmers.
Perception of water-related risks: a “value expertise” as a participatory approach

Perception of water-related risks is a complex and multifaceted issue. Water is a vulnerable good, a flood risk, a source of energy. It is a natural resource that is crucial for human life, yet it is also a source of conflict and competition. The perception of water-related risks is influenced by various factors, including personal experiences, cultural values, and scientific knowledge.

Conflicts on any water-related issues – water supply, agricultural use, or industrial pollution – are likely to involve different groups of people such as experts and citizens/lay experts. Deadlocked thinking patterns can be ascribed to these different groups. A “dead zone” exists in the Gulf of Mexico – an area that has low oxygen levels caused by pollutants. In this case, a major cause of the pollution is attributed to high concentrations of nitrogen that have been linked to intensive agriculture in the upper Midwest. Excess nitrogen fertilizer runoff from fields enters local waterways, causing problems at this level before moving into the Mississippi River watershed and eventually the Gulf of Mexico. Public opinion about water quality depends on where people get their news and how the information is presented. Research shows that news media are a major source of science information for the general public and that people living in smaller communities support local or regional news sources. The local and regional news providers rely on local input parameters.

Clean water, dirty water: Examining water quality issues in farming trade magazines

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P.77 Wang, M*; Lamberti, E; Micaleff, SA; Pradhan, AK; University of Maryland, College Park, MD; meowang@umd.edu

Quantitative Risk Assessment for Listeria monocytogenes in Cantaloupe

The U.S. multistate listeriosis outbreak associated with cantaloupes in 2011 has drawn increasing concern from the melon industry, consumers, and regulators. Considered as the second largest fresh produce commodity concerning microbial risk next to leafy greens, cantaloupe is vulnerable to pathogen contamination because of its textured rind topography and ground growing environment, where Listeria is considered ubiquitous. Recent advances of quantitative microbial risk assessment (QMRA) provide a systematic and quantitative way to evaluate food safety risk in preharvest, postharvest, and household environments. However, no QMRA has yet been developed for melons. This study aimed to develop a farm-to-fork QMRA model for Listeria monocytogenes associated with fresh-cut and whole cantaloupe consumption. The model was built on a Monte Carlo probabilistic framework, based on data from the peer-reviewed literature and communications with the industry. The model predicts that risk due to consuming a serving of fresh-cut cantaloupe is 10 times higher than a serving of whole cantaloupe. Based on an initial L. monocytogenes concentration of 0.1 CFU/cm² and 1% prevalence, the preliminary results show that estimated listeriosis burden in the U.S. associated with fresh-cut cantaloupe consumption is 0.3 and 0.001 cases per year for the susceptible and healthy subpopulation respectively. The sensitivity analysis demonstrates that temperature during retail and household storage are the two most important factors impacting risk associated with fresh-cut consumption (Spearman correlation coefficients 0.65 and 0.51 respectively), while temperature of household storage after cutting is the most crucial factor for whole melons (correlation coefficient 0.81). This QMRA model can be applied to develop improved risk-based and product-specific guidelines for the postharvest, retail, and consumer handling of melons.

T2-F.4 Wang, GS; Department of Pediatrics, University of Colorado Anschutz Medical Campus, Children’s Hospital Colorado; george.wang@childrenscolorado.org

Decriminalization of Marijuana and Impact on Unintentional Pediatric Exposures

Since 1996, 21 states and Washington D.C. have passed legislation allowing medical marijuana, and additional states are considering decriminalization. However, the marijuana industry in the US did not expand and prosper until after a Department of Justice policy in 2009 instructed federal prosecutors not to seek arrest of marijuana users as long as they conformed to state laws in the Ogden Memo. Marijuana sales are estimated to reach $5.5 billion by 2015 including sales of marijuana in non-traditional forms such as edible products (e.g. cookies, candies, beverages, concentrated tinctures, and electronic-cigarettes). These edible products are highly attractive, palatable to children and can contain high concentrations (100-500 mg) of tetrahydrocannabinoid (THC). Colorado and Washington, states that decriminalized medical marijuana in 1998 and 2000, passed state laws allowing the use of small amounts of recreational marijuana in 2014. Reports of marijuana exposures in young children have been limited historically to case reports. We described a significant increase in unintentional pediatric marijuana exposures evaluated at a children’s hospital emergency department in Colorado after federal law enforcement ceased in 2009.5 Many of these children ingested edible medical marijuana products and required inpatient hospitalization. We also described a significant increase of 30.3% in pediatric marijuana related calls per year to the American Association of Poison Control Centers National Poison Data System (NPDS) in decriminalized states from 2003 to 2011 as compared to a non-significant increase of 1.5% in calls per year in non-legal states. Subsequent policy and advocacy work with the state legislature resulted in a requirement of child resistant packaging for all marijuana products sold in Michigan, and the first requirement by any state in the US.

T3-J.4 Wang, Y*; Cha, EJ; 1. Georgia Institute of Technology, 2. University of Wisconsin-Madison; yan.wang@me.gatech.edu

On Social Value of Risk Information in Risk Communication

The conventional research of risk communication centers on how scientific community can improve trust and credibility in public perception, enhance public understanding of risks, and change public behaviors to conform to technocratic values. More recently, the emphasis of risk communication has evolved from conveying scientific data and risk information to establishing effective information flows. It has been recognized that establishing two-way communication channels among experts, governments, corporate, and general public is important to build trust relationship. With conflicting interests and coordination motive among stakeholders, the societal aspects of risk communication need to be considered. In this work, a model of social value of risk information is proposed to support risk communication with the differentiation between public and private information. Both uncertainty (due to the lack of perfect knowledge) and variability (due to individual differences in population) associated with the perceived risks are considered in the proposed model. The impact of precision and accuracy of risk information on social welfare is studied. Risk communication strategy about transparency can be devised based on the expected welfare.

W2-D.4 Wang, Y*; Zhuang, J. University of Michigan, University at Buffalo; ewang@umich.edu

A Multiple-Target Defensive Resource Allocation Game with Quantal-Response Attacking Strategies

There has been a growing interests in attacker-defender game literature on incorporating behavioral models. This research studies a new attacker-defender game over multiple targets, where the attacker is bounded rational and assumed to use quantal-response strategies. We compare the results from this new model with the ones from traditional game theory model. We study the impact of the level of being strategic on the optimal defense strategies. We validate the model using real data from both terrorism and counterterrorism databases. This research provides some novel insights to the homeland security resource allocation problems.
A Nuclear Security Application

Optimizing Resource Allocation in Adversarial Contexts:

This work presents a decision analytic framework for the computation of optimal resource allocation strategies in an adversarial context. The framework exploits a novel coupling of a game theoretic solver with a probabilistic simulation model to search the strategy space and calculate optimal strategies for the attacker and resource-constrained defender. This work seeks to address shortcomings in current threat analysis models by combining the key strength of game theory, namely the ability to optimize defender and attacker behavior in the context of the other actors’ behavior, with the realistic complexity offered by probabilistic simulation techniques. Here the framework is applied to a nuclear security problem, wherein a state with proliferant aims (the attacker) seeks to divert material from or misuse its peaceful nuclear program, and an inspector (the defender) seeks to detect such malevolent behavior. The application-specific simulation model informs the simultaneous play game theoretic solver by calculating scenario payoffs for given defender-attacker strategy pairs and populating the game’s payoff matrix. Using a modified fictitious play algorithm, the game iteratively calls the simulation model until Nash equilibrium is reached and outputs optimal defender and attacker strategies, in this case inspection and proliferation until Nash equilibrium is reached and outputs optimal defender and attacker strategy pairs and simulates the strategies. Results are presented for a defender securing a single facility or allocating resources across multiple facilities.

Researcher:
Ward, RM*; Schneider, EA; The University of Texas at Austin; rward@ips.umd.edu

T3-G.5 Wells, EM; Woodruff, TJ; Axellard, DA; Lam, J*; Purdue University and University of California at San Francisco and US Environmental Protection Agency and Johns Hopkins University; jlam5@jhu.edu

M4-E.4 Weir, MH; Temple University; weirmarkh@gmail.com

Development of a 2D Simulation Based Method for Dose Response Model Optimization for Uncertain Pathogens

Norovirus is a pathogen of increasing concern in both potable and recreational water systems as well as food production and service. All age groups are affected and norovirus has been discovered in raw well water as well as finished drinking water for utilities that use chlorination for disinfection. With the increasing level of disease burden and widespread exposure potential, a quantitative microbial risk assessment (QMRA) model is vital. However, the lack of a dose response model hampers the ability to have an accurate QMRA model. The inability to culture human norovirus has lead to this knowledge gap. Therefore, in previous work Teunis et al (2008) attempted to develop a candidate dose response model that utilized human feeding trails data using metagenomics units and a viral aggregation model (aggregation model estimated cultivable units), to optimize the models. The research to be presented here has developed a different method to utilize metagenomics data where the known conversion from genomes to aggregated viral particles for rotavirus is used in a 2-dimensional simulation method to optimize the dose response models (exponential and beta Poisson). Results are similar to those of Teunis et al (2008), however, the confidence bounds of the estimate are much tighter. Additionally based on simulated outbreaks, the 2-D simulation model shows better descriptive potential than the Teunis et al (2008) model. The method of incorporating a 2-D simulation technique directly into the optimization will be presented. By not introducing a new source of uncertainty, but rather controlling for unknown variability, this method of optimization can be very useful for emerging pathogens that may prove similar to norovirus. This new method is a potentially powerful new tool in the QMRA modeler’s toolbox. Teunis, P.F.M., Moe, C.L., Liu, P., Miller, S.E., Lindesmith, L., Baric, R.S., Calderon, R.L., 2008. Norwalk Virus: How Infectious is it? J. of Med Vir 80(8), 1468-1476

Disclaimer: The views expressed are those of the authors and do not necessarily reflect the views or policies of the U.S. EPA.

P.156 Ward, RM*; Schneider, EA; The University of Texas at Austin; rward@ips.umd.edu

Optimizing Resource Allocation in Adversarial Contexts:

This work presents a decision analytic framework for the computation of optimal resource allocation strategies in an adversarial context. The framework exploits a novel coupling of a game theoretic solver with a probabilistic simulation model to search the strategy space and calculate optimal strategies for the attacker and resource-constrained defender. This work seeks to address shortcomings in current threat analysis models by combining the key strength of game theory, namely the ability to optimize defender and attacker behavior in the context of the other actors’ behavior, with the realistic complexity offered by probabilistic simulation techniques. Here the framework is applied to a nuclear security problem, wherein a state with proliferant aims (the attacker) seeks to divert material from or misuse its peaceful nuclear program, and an inspector (the defender) seeks to detect such malevolent behavior. The application-specific simulation model informs the simultaneous play game theoretic solver by calculating scenario payoffs for given defender-attacker strategy pairs and populating the game’s payoff matrix. Using a modified fictitious play algorithm, the game iteratively calls the simulation model until Nash equilibrium is reached and outputs optimal defender and attacker strategies, in this case inspection and proliferation until Nash equilibrium is reached and outputs optimal defender and attacker strategy pairs and simulates the strategies. Results are presented for a defender securing a single facility or allocating resources across multiple facilities.

Researcher:
Ward, RM*; Schneider, EA; The University of Texas at Austin; rward@ips.umd.edu

T3-G.5 Wells, EM; Woodruff, TJ; Axellard, DA; Lam, J*; Purdue University and University of California at San Francisco and US Environmental Protection Agency and Johns Hopkins University; jlam5@jhu.edu

M4-E.4 Weir, MH; Temple University; weirmarkh@gmail.com

Development of a 2D Simulation Based Method for Dose Response Model Optimization for Uncertain Pathogens

Norovirus is a pathogen of increasing concern in both potable and recreational water systems as well as food production and service. All age groups are affected and norovirus has been discovered in raw well water as well as finished drinking water for utilities that use chlorination for disinfection. With the increasing level of disease burden and widespread exposure potential, a quantitative microbial risk assessment (QMRA) model is vital. However, the lack of a dose response model hampers the ability to have an accurate QMRA model. The inability to culture human norovirus has lead to this knowledge gap. Therefore, in previous work Teunis et al (2008) attempted to develop a candidate dose response model that utilized human feeding trails data using metagenomics units and a viral aggregation model (aggregation model estimated cultivable units), to optimize the models. The research to be presented here has developed a different method to utilize metagenomics data where the known conversion from genomes to aggregated viral particles for rotavirus is used in a 2-dimensional simulation method to optimize the dose response models (exponential and beta Poisson). Results are similar to those of Teunis et al (2008), however, the confidence bounds of the estimate are much tighter. Additionally based on simulated outbreaks, the 2-D simulation model shows better descriptive potential than the Teunis et al (2008) model. The method of incorporating a 2-D simulation technique directly into the optimization will be presented. By not introducing a new source of uncertainty, but rather controlling for unknown variability, this method of optimization can be very useful for emerging pathogens that may prove similar to norovirus. This new method is a potentially powerful new tool in the QMRA modeler’s toolbox. Teunis, P.F.M., Moe, C.L., Liu, P., Miller, S.E., Lindesmith, L., Baric, R.S., Calderon, R.L., 2008. Norwalk Virus: How Infectious is it? J. of Med Vir 80(8), 1468-1476

Disclaimer: The views expressed are those of the authors and do not necessarily reflect the views or policies of the U.S. EPA.


**P.90** Wernke, MJ*; McGee, RD; Frantz, R; Wurzel, K; Phronesia Scientific Consulting, A.L.M, Consulting, Indoor/Outdoor Environmental, NewFields Companies; mwrernke@phronesis.com

**Have Gun - Will Travel. Lead Contamination and Health Risk Assessment in Public Buildings that Previously Housed Indoor Firing Ranges**

Today, exposure to elevated lead in office buildings and schools is generally not believed to be of concern to building occupants. Depending on prior uses, that belief may be unfounded. Small arms indoor firing ranges are known to result in exposure to lead. Two structures (office building; middle school) that decades ago housed indoor firing ranges were investigated for lead contamination. Only one of the ranges underwent remediation prior to conversion to office space. Air, wipe, and soil samples were collected and analyzed for lead; some samples were also analyzed for barium and antimony as the collocation of these substances has been used to suggest the presence of gunshot residue. Sample results were compared to USEPA-derived, media specific, health-based screening criteria to assess and communicate potential health risks to building occupants and decision makers. For both buildings, air samples, soil samples, and wipe samples of surfaces possibly contacted by building occupants did not reveal the presence of lead above screening criteria. Wipe samples of surfaces generally not accessible to building occupants, in particular the HVAC systems, did reveal the presence of lead well above screening criteria. Lead, barium, and antimony were collocated in air, wipe and soil samples from both structures. These data, the rationale behind the screening criteria employed, and a comparison of the lead data to the health-based screening criteria were communicated to building occupants, decision makers, parents and the press via public meetings. Both structures were vacated to allow for remediation. Results of biological samples from some building occupants provided after data collection indicated lead levels consistent with that of the general US population. This investigation revealed that indoor small arm firing ranges could be a source of lead contamination in years after their use had ceased even if the ranges themselves underwent abatement.

**W3-D-4** Welton, AJ*; University of South Alabama; ajwelton@southalabama.edu

**Understanding Tap Water Chemical Levels in Affected Locations: Detection limits, breakdown products, home locations**

In February 2014, one month following the Elk River spill, the West Virginia Testing Assessment Project (WV TAP) science and engineering team conducted a focused water sampling study. The project was designed to assess concentration and variability of 4-MCHM in homes so that data could be used to support the design of a larger, more comprehensive sampling and assessment program for the nine counties affected. To complete this project, sensitive analytical methods were developed for 4-MCHM and breakdown product identification. Eurofins Laboratory and ALS Environmental Laboratories conducted all the tap water characterizations using adapted extraction and chemical analyses approaches. Specifically, Eurofins achieved a method detection level of 0.5 ppb and a method reporting level of 1.0 ppb; lower than any other laboratory in the US. Tap water in all 10 homes contained 4-MCHM with 90% of the samples less than or equal to 2.2 ppb. The highest level measured was 6.1 ppb. No trends were found between 4-MCHM detection and location within the house or water temperature. No breakdown products were observed in the 10 homes. Follow-up water sampling conducted in mid-March however revealed low levels of 4-MCHM present in drinking water produced by the West Virginia American Water (WVAW) treatment plant. Subsequent water sampling by WVAW confirmed WV TAP findings that 4-MCHM was desorbing from its granular activated carbon (GAC) filters into the drinking water. Resident interviews were also carried out to assess resident behaviors and perceptions following the Elk River spill.

**W3-D-5** Welton, AJ*; Rosen, JS; Patterson, J; University of South Alabama; ajwelton@southalabama.edu

**Licorice and Lessons Learned**

The Elk River spill should be a wake up call for regulatory agencies, communities and water utilities. Identification and management of potential sources of contamination by hazardous chemicals are essential to protect source waters. The Elk River spill highlights the need for regular inspection of chemical storage facilities and associated pollution prevention infrastructure and planning. For potential contaminants to water supplies, basic information on physical properties, reactivity, treatability, analytical methods, odor thresholds, and health effects should be on hand. Utilities should consider deployment of water quality sensors in their source water to quickly detect contamination. The ability for state and local officials to respond is strongly contingent on established relationships with other critical agencies. Emergency preparedness plans should be regularly tested and updated to ensure that all parts will work effectively during an emergency. As in any crisis situation, there is a need for clear, unambiguous communications of both what is and is not known. The ability of people to smell MCHM at very low concentrations aided in the detection of the leak and triggered utility and government responses to protect public health. The strong licorice odor from crude MCHM also contributed to public concern and mistrust as people continued to smell it after they were told the water was safe to drink.

**W3-D-3** Whelton, AJ; University of South Alabama; ajwelton@southalabama.edu

**The best available data: considerations in incorporating environmental studies and risk assessments into occupational risk assessment.**

Occupational risk assessments are most frequently based on occupational epidemiology studies or animal studies. However, well-conducted environmental epidemiology studies can also be used in occupational risk assessments. Examples can be found in occupational risk assessments conducted by the Occupational Safety and Health Administration and include arsenic, vinyl chloride and hexavalent chromium, in which the environmental studies informed the hazard identification and the exposure response characterization. In addition, risk assessments conducted for environmental exposures (whether based on occupational or environmental epidemiology or animal studies) can be adapted for use in occupational risk assessment. Adapting such risk assessments requires careful considerations of some key issues. Route of exposure is a critical issue for occupational risk assessment because, typically, occupational exposures are limited to inhalation and dermal routes. This may limit the direct applicability of some environmental studies or assessments (i.e., drinking water studies) to hazard identification. Other significant issues include the concentration range of the toxic substance of interest and extrapolating the exposure-response outside that range, duration of exposure (both as fraction of a day and number of years), and characteristics of the exposed population (i.e., age distribution, health, assumed breathing rate or activity level). This presentation will describe the quantitative and qualitative impact of these issues in occupational risk assessment and argue for increased collaboration between environmental and occupational risk assessors.
Ephemeral Organizations During a Public Health Crisis

T2-J.3 Wickline, MC*; Sellnow, TL; Sutton, JN; University of Kentucky, University of Colorado: Colorado Springs; morgan.wickline@uky.edu

Examining the Formation and Public Response to Ephemeral Organizations During a Public Health Crisis

The Jan. 9 contamination of the Elk River in West Virginia was the largest drinking water contamination in U.S. history. Throughout this event, the organizations involved failed to communicate efficiently and effectively with stakeholders. These missteps paired with the history of environmental contamination disasters in West Virginia have engendered outrage among citizens and distrust in the government and other organizations. The risk communication failures in this case reveal that even organizations with crisis plans in place often find themselves incapable of operating and communicating effectively during crises. Interestingly, the failures of key organizations in West Virginia created space for others to emerge as proxy communicators. During crises, concerned individuals often form spontaneous, unofficial, and ephemeral organizations to fill the information void. Specifically, these organizations are “new organizational forms and modes of action, which have been observed in the aftermath of a large scale disaster” (Lanza, 1983, p. 71). While traditional organizations are designed to function in a “normal” environment, ephemeral organizations do not rely on a formal hierarchy and set of rules and regulations for governance, allowing them to thrive in the uncertainty. In the case of the West Virginia contamination disaster, ephemeral organizations formed and took on the responsibilities that should have been fulfilled by formal organizations tied to the incident. This presentation focuses on these ephemeral organizations and the reasons they formed, the means used to form and operate during this event, and their effects on the community. The presentation is based on an analysis of initially unmet information needs, messages shared by the community. The presentation is based on an analysis of how events are perceived and framed as crises, and offer both diagnoses and recommendations for reform (a “disaster scene investigation” group).

M4-C.4 Wiener, JB*; Balleisen, E; Bennear, L; Krawiec, K; Duke University; wiener@law.duke.edu
Recalibrating Risk: Crises, Perceptions and Regulatory Change

It is often observed that crisis events can spur regulatory change, such as by changing public perceptions and by opening windows of opportunity for policy entrepreneurs. This study examines not just whether, but how, different crises can influence different types of regulatory change. We examine several case studies, focusing on oil spills, nuclear power accidents, and financial crashes (with additional examples from chemical facility accidents, aviation disasters, food safety crises, terrorist attacks, etc.), over the last 40 years, in several countries including the USA, Europe, and Japan. We observe how events are perceived and framed as crises, in a narrative that may mobilize changes in policies and institutions. We trace a variety of regulatory changes that may emerge from crises, such as tightening regulatory standards, increasing penalties, adding liability, reorganizing government agencies (e.g. combining agencies, or dividing agencies, or elevating agencies in the government hierarchy, etc.), delegating to private self-monitoring, and others. We develop a descriptive historical assessment of the types of regulatory change flowing from crises, and a normative evaluation of crisis-driven regulatory change. Strategies may benefit from both learning to prepare for crises, by developing in advance a menu of well-designed (rather than hasty) policy responses; and preparing to learn from crises, by developing a standing independent expert body (rather than an ad hoc inquiry commission) to investigate crises and offer both diagnoses and recommendations for reform (a “disaster scene investigation group”).

M4-F.1 Wikoff, DS*; Fitzgerald, LF; Haws, LC; Harris, M; ToxStrategies, Inc.; lfitzgerald@toxstrategies.com
Human health-based framework for evaluating the safety of drilling and fracturing fluid additives

Hydraulic fracturing has become one of the fastest-growing technologies for shale gas extraction in the U.S. The process involves several activities, including drilling through groundwater formations that have been contaminated with a potential to result in contamination of drinking water. Concerns are only compounded by the general lack of transparency related to the chemical products used. As regulatory oversight and reporting requirements increase, there is a need for a tool that is consistent with standard risk assessment principles to address health risks associated with the products used. We developed a quantitative framework to characterize the safety of chemical products used in drilling and hydraulic fracturing operations that applies basic principles of risk assessment for use by qualified third party assessors. The framework includes four main quantitative criteria that allow for the assessment of product identity, component toxicity, exposure, and fate & transport. The first stage requires that sufficient identity information be made available to allow for a meaningful assessment. The remaining stages of the evaluation involve scoring the product components based on risk of adverse effects, and also takes into consideration the potential for a component to reach a human receptor based on environmental fate & transport. These stages include pass/fail criteria (e.g., check component hazard against “red flag” list of hazardous chemicals) that automatically exclude components from proceeding through the screen. As demonstrated in a series of examples, final product scores can be used by risk managers to determine acceptability of a product to guide R&D objectives, or to compare the safety of product with similar functionalities. Because this process focuses on a quantitative human health risk framework, it is different than those currently available in the natural gas industry, thus allows for greater transparency within regulatory scenarios.

M3-K.4 Wilhelm, OW*; Hayden, MH; Boehnert, J; Banerjee, D; Gower, S; NCAR; olgaw@ucar.edu
Extreme heat risk and human health

Extreme heat is a leading cause of weather-related human mortality in the United States and in many countries world-wide. As global warming patterns continue, researchers anticipate increases in the severity, frequency and duration of extreme heat events. Many cities may have amplified vulnerability to extreme heat due to urban heat island and rapidly evolving socioeconomic fabric. This raises a series of questions about the increased health risks of urban residents to extreme heat, and about effective means of local-level extreme heat mitigation and climate adaptation. In this presentation, we will discuss an interdisciplinary NASA-funded project aimed at addressing these questions via the System for Integrated Modeling of Metropolitan Extreme heat Risk (SIMMER). We will highlight the SIMMER research results on the combined impact of extreme heat and the characteristics of urban environmental and social systems on human health in Houston, Texas and Toronto, Canada, and will focus on the opportunities to build local adaptive capacity for heat hazard mitigation and climate change adaptation in the public health sector. We will present key findings from Houston household and stakeholder surveys on extreme heat risk, vulnerability, and adaptive capacity. We will also discuss strategies for risk reduction and demonstrate a GIS-based tool that is aimed at communicating complex, multidisciplinary concepts of urban extreme heat risk to public health practitioners and aid in public health interventions.
Applications
Using Adverse Outcome Pathways for Regulatory Applications

In order to apply Adverse Outcome Pathways (AOPs) to reducing uncertainty in risk assessment decisions, it is necessary to assess and document the level of knowledge and confidence in the data that is used to support the pathway. Here we present four case studies demonstrating different levels of knowledge and confidence to examine how the AOP concept can be used as a qualitative and quantitative tool in hazard and risk assessment for either human health or ecological concerns. We also present a conceptual model that enables quantitative integration of data into a pathway context, based on the biological relevance of an event to the outcome, the strength of evidence for a causal relationship between key events, and the ability of a key event to infer that a chemical will cause the adverse outcome. The utility of the model is demonstrated by examining the pathway for mitochondrial fatty acid beta-oxidation inhibition leading to steatosis. For AOPs to be useful they should result in a risk assessment with higher confidence compared to current approaches and this study offers one approach to estimating the confidence of an AOP. (This abstract does not reflect policy of any of the authors’ organizations.)

P.37 Willis, AM*; Oris, JT; Toxicology Excellence for Risk Assessment; Miami University; willis@tera.org
Environmental Risk Comparison of Laboratory Photo-induced Toxicity Benchmark Values to Field Levels of Ultraviolet Radiation and Photo-reactive Contaminants

There is currently a need to assess the impact of multiple stressors in aquatic environments. Chemical and non-chemical stressors are rarely evaluated together in traditional environmental risk analyses. Chemical exposure combined with solar ultraviolet radiation (UVR) represents a multiple stressor scenario. Certain chemicals become significantly more toxic in the presence of UVR, causing photo-induced toxicity. Laboratory-generated data were used to identify toxicity benchmarks in larval zebrafish from exposure to mixtures of PAHs that also included UVR exposure. Results showed that regardless of the magnitude of the photo-enhancement effect, PAH mixtures exhibiting phototoxicity were additive. A well-fitting general toxicity model was generated for predicting toxic effects for mixtures of PAHs after taking into account differences in phototoxic potency between compounds. Using read-across methodology based on the phototoxic adverse outcome pathway, other environmental contaminants that are photo-reactive are also anticipated to have additive effects, such as pesticides and dyes. Concentrations of phototoxic environmental contaminants were identified and were combined with UVR attenuation data to evaluate the potential for photo-induced toxicity in environmental settings. It was found that photo-reactive environmental contaminants are present above the toxicity benchmarks identified, and that UVR penetration of waters is sufficient to cause phototoxicity in the environment. The phototoxicity of additional aquatic contaminants identifies potential for adverse effects well below non-UVR exposure guidance, and we find that the traditional &\#8721;PAH approach may not be sufficiently protective. Future studies should identify mixtures interactions for all photo-reactive environmental contaminants such as dyes, pesticides, PAHs, and others, in order to fully characterize the risk associated with mixtures and phototoxicity.

M3-A.4 Willett, CE*; Antczak, P; Burgoon, L; Falciani, F; Gutsell, S; Hodges, G; Kienzler, A; Knappen, D; McBride, M; Perkins, Ej; The Humane Society of the United States; kwillett@humanesociety.org

Using Adverse Outcome Pathways for Regulatory Applications

The American Cleaning Institute (ACI) has undertaken a screening-level risk assessment for all cleaning product ingredients. The first task of this project identified over 900 chemical substances that are included in the products of ACI member companies. The second task generated a database of over 5500 relevant data points from hazard studies published under REACH or HPV submissions. The present effort characterized exposure by connecting identified ingredients to specific cleaning products to intended uses and appropriate exposure models. Primary data on concentration for each ingredient was assembled from product sheets, HPV chemical submissions, trade literature, government reports, and scientific publications. Within each product category and sub-category, the suite of ingredients which comprise each formulation were identified. Each of these ingredients was assigned to one or more functional use classes to indicate their specific purpose within the product. Functional use classes from EPA’s Design for the Environment were used as a starting point, and additional classes were developed as needed. When primary concentration data was not available, ranges of concentrations were applied to ingredients based on their functional use class within each product. Exposure scenarios were based on intended uses and the associated habits and practices for the broad product categories of laundry care, dish care, and hard surface cleaners. Direct and indirect exposures for each ingredient in each product were then estimated using deterministic exposure equations. Aggregate exposures (for ingredients present in multiple product types) were also examined. The estimates of exposure developed during this task will be applied to risk assessment decision-making in the next project phase. Further refinement of these exposure estimates may occur when necessary in the risk characterization phase, to clarify the relationships between exposure and developed safety values.

M2-L.3 Williams, ES*; Ciarno, M; Horne, C; Gregg, B; DeLeo, P; Brooks, BW; Baylor University; sp williams@baylor.edu

Cleaning Product Ingredient Safety Initiative: Exposure Assessment for Ingredients

The American Cleaning Institute (ACI) has undertaken a screening-level risk assessment for all cleaning product ingredients. The first task of this project identified over 900 chemical substances that are included in the products of ACI member companies. The second task generated a database of over 5500 relevant data points from hazard studies published under REACH or HPV submissions. The present effort characterized exposure by connecting identified ingredients to specific cleaning products to intended uses and appropriate exposure models. Primary data on concentration for each ingredient was assembled from product sheets, HPV chemical submissions, trade literature, government reports, and scientific publications. Within each product category and sub-category, the suite of ingredients which comprise each formulation were identified. Each of these ingredients was assigned to one or more functional use classes to indicate their specific purpose within the product. Functional use classes from EPA’s Design for the Environment were used as a starting point, and additional classes were developed as needed. When primary concentration data was not available, ranges of concentrations were applied to ingredients based on their functional use class within each product. Exposure scenarios were based on intended uses and the associated habits and practices for the broad product categories of laundry care, dish care, and hard surface cleaners. Direct and indirect exposures for each ingredient in each product were then estimated using deterministic exposure equations. Aggregate exposures (for ingredients present in multiple product types) were also examined. The estimates of exposure developed during this task will be applied to risk assessment decision-making in the next project phase. Further refinement of these exposure estimates may occur when necessary in the risk characterization phase, to clarify the relationships between exposure and developed safety values.

W3-A.3 Willis, HH*; Fischbach, J; Warren, D; LaTourette, T; Narayanan, A; Stelzner, C; Wilder, G; Loa, K; RAND Corporation; hwillis@rand.org

Characterizing National Vulnerabilities from Infrastructure Disruptions by Natural Disasters

The nation relies on a number of infrastructure systems—roads, the electric grid, ports, telecommunications networks, refineries, and the like—for carrying out basic social and economic functions. As shown by the significant damages and lasting disruptions caused by Hurricanes Katrina and Sandy, however, there may also be a significant federal interest in policies aimed at enhancing the resilience of the nation’s critical infrastructure. A potentially invaluable role for DHS is the identification and prioritization of strategies and investments for improving the resilience of specific infrastructure systems in specific regions. This study used existing data, assembled from multiple sources, to identify and prioritize specific infrastructure elements, types, or locations vulnerable to natural disasters with the potential for severe consequences to national commerce and well-being. The results demonstrate where concentrations of infrastructure vulnerability exist geographically, what additional data would be necessary to assess and document the level of knowledge and confidence in the data that is used to support the pathway. Here we present four case studies demonstrating different levels of knowledge and confidence to examine how the AOP concept can be used as a qualitative and quantitative tool in hazard and risk assessment for either human health or ecological concerns. We also present a conceptual model that enables quantitative integration of data into a pathway context, based on the biological relevance of an event to the outcome, the strength of evidence for a causal relationship between key events, and the ability of a key event to infer that a chemical will cause the adverse outcome. The utility of the model is demonstrated by examining the pathway for mitochondrial fatty acid beta-oxidation inhibition leading to steatosis. For AOPs to be useful they should result in a risk assessment with higher confidence compared to current approaches and this study offers one approach to estimating the confidence of an AOP. (This abstract does not reflect policy of any of the authors’ organizations.)

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Communicating Multidimensional Risk Data to a Diverse Set of Stakeholders Using the Interactive Risk Visualization Tool

The Chemical Terrorism Risk Assessment (CTRA) is a DHS CSAC funded program that estimates the risk among chemical terrorism attack scenarios and assists in prioritizing mitigation strategies. Presenting multidimensional results, specifically frequency, consequence, and risk results for a wide variety of attack scenarios, in a manner that is easily digestible and understandable to stakeholders from diverse backgrounds is a perpetual challenge for the CTRA. Graphical formats are commonly more comprehensible and meaningful than vast numeric tables; however, visually capturing multiple dimensions and investigating the inherent data poses a difficult challenge. The interactive Risk Visualization Tool (RiViT) provides analysts the capability to not only view consequences, frequency, and risk results, but also aggregate those results by categories in order to meet their specific needs of their missions. RiViT is a standalone application that takes advantage of modern technology putting the power of advanced graphics visualization at the power of a user’s fingertips. The interactive chart in RiViT expands and condenses scenarios with the simple click of a mouse button or touch of a finger. The interactive chart is paired with both a tree map graphic and data table that transform as analysts use the interactive chart. Loading data into RiViT is as simple as uploading an Excel data table in a basic format. Interactive tools such as RiViT are the next generation of communicating risk following the natural progression of charts and tables. The potential applications of RiViT and its current use by CTRA analysts using notional data will be discussed.

Addressing the Challenges of Risk Communication – The CTRA Medical Mitigation Model

The Chemical Terrorism Risk Assessment (CTRA) is a DHS CSAC funded program that estimates the risk of chemical terrorism attacks to help inform and improve the US defense posture against such events. One aspect of this program is a Medical Mitigation Model—a mathematical model that simulates the public health response to chemical terrorism. Subject matter expert (SME) and stakeholder input are key sources of information as well as customers of the CTRA that utilize the results of this model. The primary challenges associated with presenting and communicating meaningful results to these parties are 1) distilling the massive amount of data (the result of 120+ chemicals, 30+ targets, etc.) into an easily consumable format and 2) presenting in an unclassified environment. The purpose of this study was to develop a presentation format for use in identifying opportunities for strategic investments and initiatives to reduce risk/consequences by better understanding the potential impact of alternative mitigation strategies (e.g., increased numbers of countermeasures). The combinations of attack scenarios were reduced by grouping chemicals into representative toxidromes (groups of chemicals resulting in similar human health effects and requiring similar medical treatments) and aggregating all target types, attack types, etc. Model results were generated for a representative chemical within each toxidrome assuming baseline response capabilities and a series of alternate strategies to assess the impact on consequences. Results were normalized according to baseline results to allow for presentation in an open forum. Comparison of simulation results indicates key areas where specific strategies can significantly impact the potential human health consequence of terrorism attacks. This presentation provides a clear example of how effectively communicated risk results can fuel public health response decision-making to better protect the US homeland.

Urban Park Use, Incidental Exposure to Ozone, and Dimensions of Livability and Well-Being: Informing Socioecological Resilience in Urban Communities at Risk

Access to safe and well-developed urban parks is a key element of efforts to increase physical activity and wellness, especially among disadvantaged populations. Monitor fast and take, park use, including proximity to residence and culture. Urban parks, home to urban forests, are a probable buffer to the adverse effects of climate change. Recent work suggests that benefits of park visits are likely unrelated to the natural park use, whereas other interventions to improve well-being are more individualized. However, there is ongoing concern for environmental quality, including air pollutants. Ozone in particular is a known risk to public health, particularly for sensitive populations. Beyond concern for park users are impacts to residents adjacent to parks. Earlier work by the authors in an affluent and disadvantaged community applied analyses of metabolic expenditures and park visitation. Findings suggested Latino park visitors were at greater risk from ozone exposure. The current work extends our inquiry by focusing on four communities, two disadvantaged and two affluent. Urban parks served as locations for observations; conducted in AM and PM blocks. Observers recorded characteristics and activities of each individual encountered, while wearing passive ozone monitors. Stationary ozone monitors were in place for a longer period of time. We compiled additional social and ecological data addressing livability and well-being at the community scale. Of particular importance is the identification of pre-existing challenges to resilience that heighten future risk considerations in light of environmental shifts associated with climate change. Results may help to elevate attention in already vulnerable communities where lesser events are likely to trigger greater adverse effects. Findings inform collaborative efforts and communications with park managers, surrounding communities, and partner organizations seeking to mitigate risk.

The influences of symbolic and practical cues on climate change decisions

Adapting to climate change impacts requires people to make more measured decisions, informed by an understanding of the relevant information attendant on their choice. Communicating this information is complicated by the politicization of the topic. In two studies, we ask how symbolic cues, designed to evoke a sense of identity as climate change believers or nonbelievers, affect a hypothetical decision: buying a home in an area subject to coastal flooding exacerbated by climate change using Zillow®. In both studies, we manipulate the frame by focusing on risks due to “elevation,” “global warming,” or both and participants’ access to an interactive decision aid to see how increased immersion in practical details affects the power of symbolic cues. Study 1 asks about climate change beliefs at the end and Study 2 primes those beliefs at the beginning. We found that denotative information overrode connotative symbolic cues evoked by references to global warming.

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Wong-Parodi, G*; Fischhoff, B; Strauss, B; Carnegie Mellon University and Climate Central; gwongpar@cmu.edu

**Resilience vs. Adaptation: Framing and Action**

Many stakeholders view climate change as requiring “resilience” or “adaptation.” We examine how those two terms affect lay responses to the risk of coastal flooding and sea level rise. In Study 1, participants spent ten minutes writing an essay about a picture with flooding, labeled with “Resilience” or “Adaptation.” Both groups judged the threat posed by future flooding similarly. In Study 2, participants used an interactive aid to evaluate moving to a coastal community with a policy of flooding similarly. In Study 2, participants used an interactive aid to evaluate moving to a coastal community with a policy of flooding similarly. In Study 2, participants used an interactive aid to evaluate moving to a coastal community with a policy of flooding similarly.

Wood, MD*; Collier, ZA; Bates, ME; Linkov, I; US Army Engineer Research & Development Center; matthew.d.wood@usace.army.mil

**Multi-criteria decision analysis: A tool for stakeholder engagement**

Multi-criteria decision analysis (MCDA; Keeney & Raiffa, 1976; Linkov & Moberg, 2011) is a well-formulated approach that has been used to facilitate effective decision making across a wide range of application domains. Many of these MCDA exercises are staged with the specific goal to facilitate a normatively optimal solution for a decision problem faced by one or more stakeholders. A growing body of work from the Army Engineer Research & Development Center, Risk and Decision Science Team has leveraged MCDA as a tool for stakeholder engagement and development of shared problem understanding in addition to creating a tool capable of evaluating decision alternatives. This portfolio of work suggests that a shared understanding of the problem’s structure is a necessary condition not only to develop a decision model, but also to engage in constructive dialogue on a problem and engage in perspective taking across stakeholder groups. A portfolio of projects demonstrating the various stakeholder engagement benefits of the MCDA process will be presented in environmental resource management and other areas, product development and acquisition, infrastructure investment, and human resources. Key considerations and future directions will be discussed. Keeney, R. L., & Raiffa, H. (1976). Decisions with multiple objectives: Preferences and value tradeoffs. New York: Wiley. Linkov, I., & Moberg, E. A. (2011). Multi-criteria decision analysis: Environmental applications and case studies. Boca Raton, FL: CRC Press.

Woodall, GM; US EPA, National Center for Environmental Assessment, RTP, NC; woodall.george@epa.gov

**Use of occupational data in deriving health effects reference values for the IRIS and AEGL Programs – Can we do better?**

Both the Integrated Risk Information System (IRIS) and the Acute Exposure Guideline Level (AEGL) Programs preferentially use human data for the derivation of health-protective reference values for the general public. More often than not, the best human data for the chemicals covered in these programs comes from occupational studies. IRIS typically develops values for chronic or lifetime durations with an assumption that continuous low-level exposures are most critical. The Reference Dose (RfD) is developed for the oral exposure route and the Reference Concentration (RfC) is developed for the inhalation exposure route. The AEGL program develops inhalation values for use in emergency response situations at five durations (10- and 30-minutes, 1-, 4-, and 8-hours) based on three severity levels (1 – mild non-debilitating effects; 2 – irreversible or affecting the ability to escape; and 3 – lethal). Several examples from these two programs will present how occupational data have been used both differently (e.g., temporal aspects and effect severity) and in common (e.g., accounting for potentially susceptible populations). Some of the innovative approaches taken with occupational data to meet the respective programmatic needs will also be explored with the goal of making the most of the available occupational study data (e.g., development of surrogates for characterizing exposure levels) and increasing the accessibility of those data and approaches across organizations charged with performing chemical risk assessments. The views expressed in this abstract are those of the author and do not necessarily reflect the views or policies of the U.S. Environmental Protection Agency.

Woodard, J.D.; Verteramo Chiu, L.J.*; Miller, A. P.; Cornell University; ljv9@cornell.edu

**Adaptation of US Agricultural Yields and Production to Drought and Climate Change**

In its 5th assessment report, the Intergovernmental Panel on Climate Change concluded “warming of the climate system is unequivocal”. Furthermore, recent droughts in Africa, Russia, China, and the United States (US), specifically in 2012, have led to increased scrutiny regarding climate change as it relates to global food security and price stability. Consequently, there has been a renewed focus on the susceptibility of agriculture to extreme weather events. For instance, a recent study by Berry, Roberts, and Schlenker (2013) refer to the year 2012 as the norm under future climate change, predicting a 20% decrease in US corn production. Lobell et al. (2014) contend that although agricultural productivity has increased in the Midwest, yields have become more susceptible to drought. However, a large body of other literature has documented and found evidence that the massive technological advancements through time have led to increased corn yields and decreases in risk around trend, even as the climate has been changing (see e.g., Woodard, 2014; Woodard et al., 2012; Woodard, Sherrick, and Schnitkey, 2011; Woodard, 2008). Whether mean productivity gains in Midwest corn yields have increased yield risk in years of extreme drought has not been thoroughly reconciled in the literature. Consequently, this study investigates the relationship between technological improvement in Midwest corn, soybean, and wheat yields and yield vulnerability under forecasted climate change. We ask, has historical adaptation to mean climate change in the US come at the expense of increased susceptibility to extreme weather events such as drought? Understanding this relationship is important in order to better assess future impacts of climate change to agricultural production. For instance, we could simulate crop yields based on different technological assumptions and IPCC weather scenarios, allowing us to estimate the impact of future droughts on corn production, prices, and demand for crop insurance.

**W3-I.3**

Woodall, GM; US EPA, National Center for Environmental Assessment, RTP, NC; woodall.george@epa.gov

**Use of occupational data in deriving health effects reference values for the IRIS and AEGL Programs – Can we do better?**

Both the Integrated Risk Information System (IRIS) and the Acute Exposure Guideline Level (AEGL) Programs preferentially use human data for the derivation of health-protective reference values for the general public. More often than not, the best human data for the chemicals covered in these programs comes from occupational studies. IRIS typically develops values for chronic or lifetime durations with an assumption that continuous low-level exposures are most critical. The Reference Dose (RfD) is developed for the oral exposure route and the Reference Concentration (RfC) is developed for the inhalation exposure route. The AEGL program develops inhalation values for use in emergency response situations at five durations (10- and 30-minutes, 1-, 4-, and 8-hours) based on three severity levels (1 – mild non-debilitating effects; 2 – irreversible or affecting the ability to escape; and 3 – lethal). Several examples from these two programs will present how occupational data have been used both differently (e.g., temporal aspects and effect severity) and in common (e.g., accounting for potentially susceptible populations). Some of the innovative approaches taken with occupational data to meet the respective programmatic needs will also be explored with the goal of making the most of the available occupational study data (e.g., development of surrogates for characterizing exposure levels) and increasing the accessibility of those data and approaches across organizations charged with performing chemical risk assessments. The views expressed in this abstract are those of the author and do not necessarily reflect the views or policies of the U.S. Environmental Protection Agency.

December 7-10, 2014 - Denver, CO
M2-I.2 Wright, JM*; Rivera-Núñez, Z; US EPA; wright.michael@epa.gov
THE EFFECT OF DISINFECTION BY-PRODUCT EXPOSURES ON RISK OF BIRTH DEFECTS

Previous epidemiological studies suggest that women exposed to DBPs have an increased risk of delivering babies with neural tube, genitourinary system, and ventricular septal defects. The risk of birth defects (3500) from 75-79 towns in Massachusetts was examined relative to different water sources, disinfection types, and DBP concentrations using 2000&39;61485;2004 data. Preliminary unadjusted and adjusted results for combined birth defects were largely null among the water source and disinfection exposure metrics. Adjusted odds ratios (ORs) ranged from 1.17 to 1.37 for obstructive urinary defects among births linked to drinking water treated with chlorine, chloramines, and other alternative disinfectants compared to untreated ground water systems. aORs for cardiac defects among births linked to chlorinated and chloraminated water compared to untreated ground water ranged from 1.08 to 1.14. aORs ranged from 1.17 to 1.19 for hypospadias and epispadias among births linked to chlorinated surface water and chloraminated water compared to untreated ground water. Preliminary analyses showed no increased risk of combined BDs for total trihalomethane or total haloacetic acid exposures compared to the lowest quintiles. Small increased risks for VSDs were found for the upper two brominated trihalomethane quintiles (aOR range=1.05-1.24), while increased risks for obstructive genitourinary defects were detected for the upper three bromodichloromethane (aOR range=1.10-1.51) and total brominated trihalomethane (aOR range=1.61-1.91) quintiles. Preliminary analyses indicate larger risks for BDs for the brominated DBPs, but further analyses are needed to confirm these results. The views expressed herein are those of the authors only and do not necessarily reflect the views or policies of the USEPA.

P.194 Wright, JM; US EPA; wright.michael@epa.gov
The Weight of Evidence for Fetal Growth Restriction Related to Disinfection By-product Exposures

Previous epidemiological studies have shown associations between disinfection byproduct (DBP) exposures and some adverse reproductive outcomes, including ventricular septal defects (VSDs), small for gestational age (SGA) infancy and lower mean birthweight (BWT). Differences between studies will be highlighted based on different study design elements such as whether exposure data are based on individual-level estimates or town-level exposures. Based on a review of the literature comparing high versus low exposure categories, consistent increased relative risks (RRs) of SGA (RR range=1.06-1.50) were detected among 12 out of 15 studies that used 3rd trimester aggregate THM4 exposures. Consistent mean BWT reductions ranging from 19-70 grams among high exposure groups were detected among four out of five of these studies. Two studies reported BWT deficits among those with high HAA5, DBP9 (sum of HAA5 and THM4) and total organic halide exposures. BWT reductions were noted for urinary haloacetic exposures (160 grams) and an internal THM4 dose estimates (47 grams). Previous meta-analyses indicate that the strongest evidence between DBP exposures and congenital anomalies were for cardiac defects, including VSDs, and urinary tract defects. Similar results for VSDs were noted (RR range=1.43-1.81) across three studies with aggregate THM4 measures which are consistent with our ongoing epidemiological research that show limited evidence of exposure-response relationships in many of these studies, however limitations such as narrow exposure gradients and exposure misclassification limit the ability to examine this. Future analyses will include comparison of effect estimates between those based on aggregate exposure measure and more direct estimates of individual-level exposures. Although the associations noted for these three outcomes are relatively small in magnitude, the consistency of the reported findings warrant future consideration. The views expressed in this abstract are those of the authors and do not necessarily reflect the views or policies on the U.S. EPA.

P.181 Wu, TT*; Pan, ZC; Ho, WC; Lin, MH; Fan, KC; Chen, PC; Lin, CC; Wu, TN; Sung, FC; Lin, RS; China Medical University; martinwu1006@gmail.com
Impact of Air Pollution and Statins Use on Stroke among Hypertension Patients: A Population-Based Cohort Study in Taiwan

There is growing evidence of the association between air pollution and the incidence and mortality of cardiovascular diseases especially stroke, which have had high risk to suffer among people who had hypertension. Stains are widely used for hyperlipidemia and cardiovascular disease by their cholesterol-lowering effect. Due to pleiotropy of statins, there are many study reported that statins are related to improve risk-awareness of climate change, showed that the media frequently fails to convey scientific uncertainty regarding the main causes of climate change. Stains may reduce the risk of stroke occurring among people who had hypertension. Stains are highly engaged in politics, and provide feedback information for public understand various issues and increase their engagement in politics, and provide feedback information for policy makers. Although climate change is one of the world&rsquo;s most significant and highly uncertain risks, public still have limited understanding of the issue and have not engaged as a collective group in politics. Existing studies covered various potential causes of missed climate reporting and its influence on public low risk-awareness of climate change, showed that the media frequently fails to convey scientific uncertainty regarding climate change mainly due to news reporters lacking science knowledge. However, few people framed this problem from the perspective of international climate policies, the most urgent target for climate policy nowadays, ignoring the crucial relations among mass media, public, science and international politics. By investigating the content of four quality newspapers presented in four newspapers from the United States, the United Kingdom, China and Australia, during the COP conferences period from the 3rd to 18th, this paper wants to explain the potential reasons and predict the influence of different reporting, further give a clue to analyses of the potential influence of the elite media on international climate policy.
Reducing uncertainty through the tiered exposure assessment for organic solvent in Japan.

In Japan, July 2010 the Ministry of Health, Labour and Welfare (MHLW) published “Committee Report on a Chemical Management Framework in Workplaces”. This report described the updated tools for changing the chemical substances and clarified the requirements of a tiered risk assessment to rationally managing chemical substances. Especially it emphasized the needs to (1) introducing the first level risk assessment method, (2) making the whole level of their working environment measurement, and (3) discussing the implementation of the measurement by using the personal sampler.

In Europe, the exposure model has been applied to the tiered risk assessment in workplace. In recent years, the probabilistic occupational exposure model, ART (the Advanced REACH Tool), has developed by TNO in Netherlands. This model can probabilistically estimate the personal exposure concentration by inputting the context information of exposure situation in each workplace. The purpose of this research is to evaluate the utility of performing the tiered exposure assessment by using the probabilistic exposure model under Industrial Safety and Health Law in Japan. Particularly, we applied the VOI (Value Of Information) approach for the tiered occupational exposure assessment of organic solvent in Japan.

We performed three steps exposure assessment depending on data availability. Firstly we assessed the exposure of workers by the only observed data of working environment measurement. And then the second assessment estimated the probabilistic exposure distribution of workers by ART. In the final step the estimated exposure distribution by ART was updated by the Bayesian method using observed personal exposure levels. In addition, the optimal management measurement at each exposure assessment step was selected, respectively. The difference of expected losses in each optimal management level of their working environment measurement, and (3) discussing the implementation of the measurement by using the personal sampler. In Europe, the exposure model has been applied to the tiered risk assessment in workplace. In recent years, the probabilistic occupational exposure model, ART (the Advanced REACH Tool), has developed by TNO in Netherlands. This model can probabilistically estimate the personal exposure concentration by inputting the context information of exposure situation in each workplace. The purpose of this research is to evaluate the utility of performing the tiered exposure assessment by using the probabilistic exposure model under Industrial Safety and Health Law in Japan. Particularly, we applied the VOI (Value Of Information) approach for the tiered occupational exposure assessment of organic solvent in Japan. We performed three steps exposure assessment depending on data availability. Firstly we assessed the exposure of workers by the only observed data of working environment measurement. And then the second assessment estimated the probabilistic exposure distribution of workers by ART. In the final step the estimated exposure distribution by ART was updated by the Bayesian method using observed personal exposure levels. In addition, the optimal management measurement at each exposure assessment step was selected, respectively. The difference of expected losses in each optimal management level of their working environment measurement, and (3) discussing the implementation of the measurement by using the personal sampler. In Europe, the exposure model has been applied to the tiered risk assessment in workplace. In recent years, the probabilistic occupational exposure model, ART (the Advanced REACH Tool), has developed by TNO in Netherlands. This model can probabilistically estimate the personal exposure concentration by inputting the context information of exposure situation in each workplace. The purpose of this research is to evaluate the utility of performing the tiered exposure assessment by using the probabilistic exposure model under Industrial Safety and Health Law in Japan. Particularly, we applied the VOI (Value Of Information) approach for the tiered occupational exposure assessment of organic solvent in Japan. We performed three steps exposure assessment depending on data availability. Firstly we assessed the exposure of workers by the only observed data of working environment measurement. And then the second assessment estimated the probabilistic exposure distribution of workers by ART. In the final step the estimated exposure distribution by ART was updated by the Bayesian method using observed personal exposure levels. In addition, the optimal management measurement at each exposure assessment step was selected, respectively. The difference of expected losses in each optimal management level of their working environment measurement, and (3) discussing the implementation of the measurement by using the personal sampler.
Saccharin is widely used in foods and drinks as a food additive and legally used in foods in eighty countries worldwide. Although saccharin caused bladder tumors to rats, its mode of action in human is still inconclusive. In Taiwan, Food and Drug Administration (TFDA) permits the use of saccharin in candied fruit, carbonated drinks, and some special nutrients. The daily exposure to saccharin has been of great concerns. Therefore, the objective of this study was to conduct a probabilistic exposure assessment for saccharin through daily consumption of candied fruits and carbonated drinks with newly-developed Bayesian statistics Markov chain Monte Carlo simulation to better characterize the distribution and uncertainty of daily saccharin intakes. The residue of saccharin was cited from reports released by the Control Yuan Republic of China; the 15 samples of candied fruit range from ND to 16.29 g/kg. The concentration of saccharin in carbonated drinks was cited from Italy is 1.0±8.0 mg/kg(n=75). The body weights of people in Taiwan and intake rates of candied fruits were cited from the Taiwan National Food Consumption Database. These data were used as prior information. The posterior distributions of saccharin residues in candies fruits and carbonated drinks were reconstructed, the daily intake of saccharin were calculated by NOAL cited from JECFA and EFSA. By exposure assessment, LADD is 0.10 mg/kg, HI is 0.02 and HI for 95% is 11.87 mg/kg, HI is 2.39 and HI for 95% is 6.40 for consumer-only; LADD is 0.10 mg/kg, HI is 0.02 and HI for 95% is 0.008 for population of all. MOE is 42.1 for consumer-only and 4,854 for population of all. It demonstrates that the government has to control the concentration of candied fruit and the risk of consumer-only is unacceptable.

The Department of Defense (DoD) has developed a Sustainability Analysis (SA) which employs a Streamlined Life Cycle Assessment process. The SA can be used to compare design alternatives for major system acquisitions and can also be used to compare new products and processes. The SA provides two outputs: (1) the relative environmental and human health impacts of alternatives from cradle to grave, and (2) the life cycle costs of the alternatives. The SA will help make better design choices regarding energy sources, chemicals/materials, and water and land use. The presentation will show the framework of the SA and Streamlined Life Cycle Assessment process. Using an actual case study, the presentation will also demonstrate how the SA can reduce risks over the life of systems such as aircraft and reduce the “Total Cost of Ownership.”

Tobacco products are complex and include a mixture of components, ingredients, additives, and in many cases, emit chemical byproducts. Further, tobacco product use patterns are variable and depend on product type; these exposure patterns are used to estimate risk to users (and non-users). Pharmacological and toxicological dose-response relationships are key in the understanding of products and crucial to pair with exposure patterns. Clear, scalable dose-response relationships for these complex mixtures in tobacco products are often not available. Historically, risk assessment has been used to estimate the risk of adverse health effects from exposure to harmful substances and to provide support for risk management decisions. Various centers of the FDA have utilized diverse risk assessment methods in executing their statutory authority. An evaluation of the toxicological or pharmacological impacts of tobacco products on individuals and the population (i.e. an assessment of tobacco product risk) requires (1) tobacco product exposure patterns and (2) dose-response relationships of the components, ingredients, additives, and/or byproducts. The classic paradigm of risk assessment necessitates a complete description of the explicit and implicit assumptions when reporting the methodology proposed for comparing risks. Research is needed to further develop the understanding of exposure patterns specific to whole tobacco products as consumed by the user and of dose-response relationships of tobacco products and/or their components, ingredients, additives and/or byproducts. These relationships may provide evidence to support review of tobacco products applications, the development of regulations and guidance, and/or the development of predictive models (i.e. risk assessment, population modeling).
Taiwan. urgent issue, and the current regulation is appropriate on NP in

indicate that the daily exposure to NP in Taiwan is not an

percentile is about 8000. The results

percentile is 1.2×10⁻². The mean margin of exposure (MOE) is

corresponding mean hazard index (HI) is 5.1×10⁻³ and the 95

daily dose (LADD) for Taiwanese population is 325.2 ng

dose, 60 μg/kg/day, was assessed with Benchmark dose

Statistics Markov chain Monte Carlo simulation. The reference

and food and daily intake were assessed with Bayesian

Statistics Markov chain Monte Carlo simulation. NP in

sediment, river water, and treated water were collected for this

study. The NP level in food, including aquatic products, rice,

noodles, meat, eggs, milk, vegetables and fruits, were also

collected. The exposure factors were cited from the National

Food Consumption Database and Compilation of Exposure

Factors in Taiwan. These data were used as the prior

information. The posterior distributions of NP in each media

and food and daily intake were assessed with Bayesian

Statistics Markov chain Monte Carlo simulation. The reference
dose, 60 &amp; #956;g/kg/day, was assessed with Benchmark dose

mode HI and the 95 percentile is 796.5 μg/kg/day. The

mean of the lifetime average daily dose (LADD) for Taiwanese population is 325.2 ng NP/kg/day, and the 95 percentile is 796.5 μg/kg/day. The
corresponding mean hazard index (HI) is 5.1×10⁻³ and the 95 percentile is 1.2×10⁻². The mean margin of exposure (MOE) is

about 28000 and the 95 percentile is about 8000. The results

indicate that the daily exposure to NP in Taiwan is not an urgent issue, and the current regulation is appropriate on NP in Taiwan.

Inhalable particulate matter phase PAHs during heating season in Beijing, China

Recently, inhalable particulate matter pollution gets increasingly serious in China, which influences human public health and the ecological environment. Human exposure to PAHs (polycyclic aromatic hydrocarbons), causes carcinogenic, mutagenic and teratogenic effects to human. Most people spend much longer time indoors compared with the outdoor activities; therefore, the indoor and outdoor exposure turns to be imperative for inhalable particles health risk assessment. In this study, we utilized an estimation indoor/outdoor exposure coefficients model to obtain the exposure time and exposure concentration of inhalable particulate matter of residents during winter season in Beijing, China from 2011 to 2012. Based on the estimation results, we analyzed the inhalable particulate matter samples using liquid chromatogram methods to test 16 PAHs, while only 14 PAHs detected in the samples due to the volatility. The concentration of PAHs was in range of 0-123.6 ng/m³. With BaP toxic equivalency factors, we estimated the cancer risk of the 14 PAHs of indoor and outdoor inhalable particulate matter exposure. The analysis results showed that there was a slowly decrease trend of health risk in Beijing from 2011 to 2012. The outdoor PAHs exposure was highly associated with the indoor exposure, and also had higher health risk compared with indoor exposure if it was under steady airflow condition. The results illustrated that the health risk will decrease with the effective inhalable particulate matter control measurement, especially during the heating season with a lot of coal consumption. Additionally, the indoor activities should be encouraged to avoid the health risk when it is highly polluted of outdoor environment.

Community engagement and risk perception in disaster preparedness in Canada: A systemic approach

Disaster preparedness has become an important theme in the public safety of Canada as the Canadian population is at risk of significant loss due to natural disasters. Past studies have demonstrated the socio-cultural factors in shaping individuals’ risk perceptions and behavioural responses to hazards. There is little research to-date that investigates how volunteering and participating in community organizations or ‘community engagement’, which can influence individuals’ risk perceptions and disaster preparedness. The present study investigated the relationship amongst community engagement, psychological dimensions of risk perception for natural disasters and disaster preparedness by analyzing data from a nationally representative survey (n = 3,263). Exploratory and confirmatory factor analyses of a series of natural disaster risk perception belief statements showed that Canadians’ psychological dimensions of risk perception were ‘self-preparedness’, ‘illusiveness of preparedness’, and ‘external responsibility for disaster management’. Multivariate regression analyses showed that community engagement and psychological dimensions of risk perception (e.g., self-preparedness) positively predicted preparedness behaviours (e.g., discuss preparedness information with others). Community engagement only negatively predicted a type of psychological dimension of risk perception which was illusiveness of preparedness. A follow-up mediation analysis showed that the relationship between community engagement and preparedness behaviour may be partially mediated by illusiveness of preparedness. Findings suggest that community engagement may be an alternative path to foster disaster preparedness, especially for individuals who believe in the illusiveness of preparedness. The relationship amongst community engagement, preparedness, behaviour and risk perception is multifaceted. Theoretical and practical implications will be discussed.
P.136 Yu, HL*; Chiu, CH; National Taiwan University; hlyu@ntu.edu.tw
A spatial risk assessment for dengue fever incidences by accounting for environmental and socioeconomic factors

Understanding spatial characteristics of dengue fever occurrences is important for governmental agencies to implement effective strategies for disease control. This study investigates the associations between the environmental and socioeconomic factors and dengue fever distributions across space. We proposed a probabilistic risk assessment approach by using a threshold-based quantile regression method to identify the significant risk factors for DF transmissions and to estimate the spatial distribution of dengue fever risks in terms of full probability distributions. For the purposes of risk interpretations, the idea of return period was also introduced to characterize the frequency pattern of dengue fever occurrences across space. The study area includes old Kaohsiung city and Fongshan district, where has been suffered the most severe dengue fever infections in Taiwan during recent decades. Our results identified that the water-related facilities, including canal and ditches, and residential areas of different kinds, as well as the interactions among these factors are significant factors to elevate dengue fever risks. The spatial distributions of dengue fever risks are shown in terms of two distinct presentations, i.e. incidence rates at different return periods, and return periods at different incidence rates. These probability-based spatial risk maps present distinct dengue fever risks associated with environmental factors in terms of different magnitudes and occurrence probabilities across Kaohsiung, which can be a reference for local governmental agencies.

SRA 2014 Annual Meeting Abstracts

December 7-10, 2014 - Denver, CO

P.50 Yuyama, A*; Kajitani, Y; Central Research Institute of Electric Power Industry; yuyama@criepi.denken.or.jp
Identifying Interdependent Issues and Resource Limitations for Modeling Post-Earthquake Recovery Duration of Critical Infrastructures: The Case of 3.11 Earthquake in Japan

Our society greatly depends on the function of critical infrastructures such as electric power, gas, water, telecommunication and transportation system. As shown by recent natural disasters, disruption of these systems causes massive impacts on the society and becomes one of the major obstacles in rapid recovery of life and business. Therefore, predicting how long the malfunction of infrastructure services lasts in the affected area is necessary to enhance the disaster preparedness of the society and mitigate the adverse consequences. Myriad of works have been devoted to this issue, though, predicting recovery duration of infrastructures and its geographical distribution is still difficult because the outage time of systems depends on not only the features of the system itself (e.g. component vulnerability and network structure etc) but also combination of some external factors. Functionality of the surrounding systems, restoration strategy and resulting allocation of resources are examples of such elements. In this study, we addressed the impact of system interdependencies and resource limitations on recovery of critical infrastructures by collecting and analyzing actual recovery data and other related indices from the 3.11 Great East Japan Earthquake based on statistical models.

P.7 T2-J.7 Yuan, S*; Besley, JC; Michigan State University;
yuanshup@Msu.edu
The priming effects of Fukushima Nuclear Disaster and Tokyo 2020 Olympic Games on the Country Image of Japan

Countries that host an Olympic Games may hope that a successful event will have a positive impact on that country’s image. In the case of Japan, there may also be the hope that hosting the games might help move a country’s image beyond the 2011 nuclear disaster at Fukushima. This study therefore looked at whether priming respondents to think about the Olympics might affect people’s attitude toward Japan in the context of Fukushima. Priming effects can be defined as “facilitative effects of an encounter with a stimulus on subsequent processing of the same stimulus (direct priming) or a related stimulus (indirect priming)” (Tulving, Schacter, & Stark, 1982, p.336). Based on past priming research, we explored differences in attitudes toward Japan when respondents were asked about Tokyo 2020 Olympic Games and Fukushima nuclear disaster in different orders. The results (N=406) showed that asking about the Fukushima nuclear disaster and Olympic Games before asking about Japan affected views about Japan. However, the effect was limited. When the order was Tokyo Olympic Games-Japan-Fukushima, there was no positive impact on views about Japan. However, when both Fukushima and the Olympic Games were asked about before Japan, views about Japan were more positive than when the order was Fukushima-Japan-Olympic Games (but still more negative than asking about Japan first). In other words, mention of the Olympic Games diminished the negative impact of Fukushima on perceptions of Japan. The findings of this study provide evidence that hosting large events such as Olympic Games may help countries recover their images following risk events.

W4-G.3 Zeise, L*; Bois, FY; Chiu, WA; Hattis, D; Rusyn, I; Guyton, KZ; California Environmental Protection Agency Office of Environmental Health Hazard Assessment; lauren.zeise@oehha.ca.gov
Addressing Human Variability in Human Health Risk Assessments of Environmental Chemicals using Emerging Data Streams

Human variability in the degrees and ways in which people respond to environmental chemicals stems from intrinsic (heritable traits, life stage, aging), and extrinsic, exogenous, and acquired factors (e.g., background health conditions, co-occurring chemical exposures, food and nutrition status, psychosocial stressors). Interactions between these factors create the large range of biological variation exhibited in response to a chemical exposure. We explore how next-generation human health risk assessments of chemicals might take advantage of novel data to better characterize and quantify variability in susceptibility. Biological variability can be described through the conceptual framework of the source-to-outcome continuum. This framework can help guide the development of approaches to describing variability in susceptibility in human health risk assessments and provide a context for considering emerging data streams that may be informative in characterizing human variability in susceptibility. We consider the opportunities, challenges and methods for using emerging data to help assess interindividual variability in responses to environmental chemicals.
Environmental Monitoring and Risk Assessment

Risk assessment methods developed to evaluate emissions typically focus on heavy metals such as arsenic, cadmium, lead, and mercury (Hg) and products of incomplete combustion such as polychlorinated dibenzo(p)dioxins/furans (PCDD/Fs) and polycyclic aromatic hydrocarbons (PAHs). These compounds persist and bioaccumulate, multi-pathway risk assessments typically use a series of sequential, interconnected models to predict pollutant dispersion in air, deposition to soil/water, and foodweb transfer. The distribution of pollutant concentrations among environmental media is then used as the basis of estimating exposure among all potentially relevant pathways. For contaminants such as Hg and PCDD/Fs, top-of-food chain pathways are predicted to be most important. Environmental monitoring studies (EMSs) are sometimes used in an attempt to confirm the predictions of fate-and-transport models and seek evidence of the impacts of specific emission sources. Our talk will focus on the challenges associated with environmental monitoring studies, with specific application to the cement kiln industry in Portugal. As there are many sources of combustion-related pollutants, a facility-based EMS must account for both natural and anthropogenic background (i.e., signal to noise issues). Emissions from modern, well-controlled cement kilns have been greatly reduced such that signal to noise issues). Emissions from modern, well-controlled cement kilns have been greatly reduced such that facility-specific impacts cannot easily (if at all) be distinguished. Statistical sampling considerations thus become important, as well the design of sampling studies based on patterns of projected impacts. Use of biomonitoring (e.g., lichens) has been investigated in an attempt to focus on bioaccumulate endpoints. Our talk will explore potential relationships between bioaccumulation modeling and biomonitoring using recent data collected around operating cement kilns.

Optimal Allocation of Defensive Resources in Countering Terrorism: Modeling and Validating

Combating terrorism is a global issue to protect the public property and lives. How to allocate defense resources effectively and efficiently to prevent the damage is always a critical and difficult question, especially facing with adaptive attackers and various attack types. There has been a growing literature on attacker-defender games in the past decade; however, to our best knowledge, none of the literature considers multiple attacker types, while different attack attack types have been used in different events. In this research, we present a novel class of multi-period and multi-target attacker-defender games where the attackers may have multiple attacking options including assassination, armed assault, bombing/explosion, facility/infrastructure attack, hijacking, hostage taking and un armed assault. Facing with multiple attack types, the defender distributes limited resources to the multiple targets to minimize the total expected loss in each period in a sequential game as the first mover. We provide some analytical results, algorithm to solve this game, as well as numerical illustrations. The model is validated by: (a) using historical terrorism and defensive investment data to estimate the model parameters, and (b) comparing the historical resource allocation and model outputs. Compared with the scenario that does not consider multiple attack types, this model gives a lower expected loss, especially when: (a) when the budget is tight or defense effectiveness is low, most of the defensive resources would be allocated to the most valuable targets such as New York City; (b) as the carried-over coefficient goes higher, the allocation to the most valuable targets decreases and the allocation to the less valuable targets increase; and (c) the model results lead to a much lower expected loss than the one results from the historical allocation. This paper provides some new insights on modeling and validating defensive resource allocation models related to adaptive adversary.

Multidimensional Injury Pattern Analysis: A Study of Child Prod in Japan

A multidimensional injury pattern analysis method is proposed based on epidemiological injury data description framework. The usefulness of the method is demonstrated through the case of product caused injuries of child in Japan. In the preparation phase, injury information taken from the Japanese National Institute of Technology and Evaluation (NITE) was tailored to construct a multidimensional data set composed of five factors, host (victims), agent (hazards), vector (products), environment and result (injuries). Each factor is further broken down to thirty one data items. In the analysis phase, two matrices are used. Multi-dimensional injury pattern matrix is used to identify the most typical combinations of risk factors, and risk level matrix is used to evaluate the risk level of identified injury factor combinations. The demonstration is done through two steps. In the first step, the most typical child injury cases were identified for two categories of products, those designed only for child use (toys and baby use goods, for example) and those designed for not specified users (users are mostly adults), at two-dimensional injury patterns (hazard + mechanism) level. In the second step, the identified injury cases are further analyzed by adding two dimensions (injury type and age of victim) to investigate toy-related injuries for children. This method allows product designers and others interested in the safety of products to better understand the causes of injuries and to target potential solutions. Including assassination, armed assault, bombing/explosion, facility/infrastructure attack, hijacking, hostage taking and un armed assault. Facing with multiple attack types, the defender distributes limited resources to the multiple targets to minimize the total expected loss in each period in a sequential game as the first mover. We provide some analytical results, algorithm to solve this game, as well as numerical illustrations. The model is validated by: (a) using historical terrorism and defensive investment data to estimate the model parameters, and (b) comparing the historical resource allocation and model outputs. Compared with the scenario that does not consider multiple attack types, this model gives a lower expected loss, especially when: (a) when the budget is tight or defense effectiveness is low, most of the defensive resources would be allocated to the most valuable targets such as New York City; (b) as the carried-over coefficient goes higher, the allocation to the most valuable targets decreases and the allocation to the less valuable targets increase; and (c) the model results lead to a much lower expected loss than the one results from the historical allocation. This paper provides some new insights on modeling and validating defensive resource allocation models related to adaptive adversary.

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In the last few years America was rocked by a series of industrial disasters such as 2012 Chevron refinery fire in California, 2008 Imperial Sugar refinery explosion in Georgia, and 2005 BP’s Texas City explosion. These high profile disasters are just the tip of the iceberg. There are less sensational failures occurring daily, most of which have serious and even fatal consequences to thousands of individuals across the world. Media rarely or under-report industrial disasters or failures that occur daily, but their accumulative fatalities can be comparable or even greater than those of high profile events. In literature, there is a lack of content analysis on media report of occupational injury. Risk perception shaped and influenced via media report may not reflect the real risk as reported by surveillance data. In literature, there is also a lack of comparison between surveillance data and mass media report: Using state-level fatal occupational injury as an example. In the preparation phase, injury information taken from the Japanese National Institute of Technology and Evaluation (NITE) was tailored to construct a multidimensional data set composed of five factors, host (victims), agent (hazards), vector (products), environment and result (injuries). Each factor is further broken down to thirty one data items. In the analysis phase, two matrices are used. Multi-dimensional injury pattern matrix is used to identify the most typical combinations of risk factors, and risk level matrix is used to evaluate the risk level of identified injury factor combinations. The demonstration is done through two steps. In the first step, the most typical child injury cases were identified for two categories of products, those designed only for child use (toys and baby use goods, for example) and those designed for not specified users (users are mostly adults), at two-dimensional injury patterns (hazard + mechanism) level. In the second step, the identified injury cases are further analyzed by adding two dimensions (injury type and age of victim) to investigate toy-related injuries for children. This method allows product designers and others interested in the safety of products to better understand the causes of injuries and to target potential solutions.

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The influence of self-other relevancy on perception of proportions of different PM2.5 sources

Urban air pollution is one of the most serious environmental risks. Available research suggests that public do not realize the severity of the air pollution risk and efforts made to cope with this problem have limited effects. To some extent, this is because the responsibility of causing this problem is not clear to people, or to policy makers. Attribution theory provided one possible explanation to the uncertainty of responsibility; people may attribute most of the air pollution to sources they do not participate in, such as industry, and construction. If this is true, people will be reluctant to make efforts to reduce the emission of pollutants by themselves. PM 2.5 is a major air pollutant and its level is usually used to represent air quality. The current study took PM 2.5 as a tool to explore whether the there is an attribution bias in assigning the responsibility of producing this air pollutant. Specifically, the current study aimed at studying how people see the roles of themselves in different sources of PM 2.5, such as industry, and vehicle driving. We also attempted to examine the relation between how people perceive their participation in each source, how they perceive the contribution of each source in producing PM 2.5, and benefit of each source. Finally, we tried to provide some suggestions on effective risk communication for policy makers by comparing people's perception on different sources with official proportion data from EPA. In order to do so, we distributed 200 questionnaires among college students. Percent proportion of different PM2.5 sources, perceived benefit of different PM2.5 sources, and one’s own participation in each PM2.5 source were measured. Preliminary results from interviews before the large-scale survey displayed anticipated bias in assigning proportion of each sources for producing PM 2.5.
Abstract: This study uses an integrated ABM to simulate how people’s mitigation/adaptation strategies influence the household level hurricane wind damages for Anne Arundel County, Maryland. Maximum wind speeds were estimated for every household by using synthetic wind fields simulated along historical storm tracks. We considered all storms passing through the state of Maryland and within 500 km of the state border since 1851. Household damages were estimated stochastically from both simulated wind speeds and probabilities given by the wind damage fragility curves from the FEMA HAZUS. Adjustments of the probability were also made according to the local surface roughness and the construction quality of the house. Each individual household will have their own mitigation/adaptation strategy (e.g., strengthen their house) if they are directly or indirectly influenced by each storm and therefore it influences their probability of damage in the next storm. This ABM will run for several scenarios with different mitigation/adaptation strategies of people. The spatial and temporal variations of the wind damage will be compared for different mitigation scenarios. This agent-based model will offer us an innovative approach to examine how people’s decision influence their risk in natural disasters such as hurricane.

M2-J.5 Zimmerman, R; New York University; rae.zimmerman@nyu.edu
Breaking the barriers: Communication networks for risk reduction in technological disasters

Record-breaking disasters of the 20th and 21st centuries have produced adverse consequences often exacerbated by communication failures. Effective communications are significant for risk reduction, influencing decisions about pre-positioning and allocating resources and moving people and assets. Communication failures and successes in technological disasters are evaluated using network concepts for case-based data. Common communication principles are derived to design and implement future communications to reduce catastrophic consequences to life, property, and the environment. Network concepts are applied to a range of technologies, e.g., energy, communication, and transportation and hazard types disrupting those technologies, e.g., extreme weather and geophysical phenomena. Communication patterns readily lend themselves to network modeling. Though network concepts have traditionally been used for communication, novel ways of using network concepts for communications related to disasters are emerging. A few examples are given here. First, a network-based model is used to portray communication centralization, e.g., a single, dominant node or path that restricts communication flow by impeding information verification. Also, the instability of information from centralized nodes can go undiscovered, e.g., constantly and suddenly changing weather forecasts from a single source can misdirect actions. Second, communication structures often have multiple interacting nodes, ranging from high levels of government to front-line responders; linkages among them are required that can be activated quickly for effective interaction in a disaster. Weak linkages among designers, managers and operators contributed to some historic bridge failures. Third, equipment malfunctions can disrupt communications, e.g., the absence of communication equipment in NYC’s 2010 snowstorm impeded snow removal. Network concepts capture these attributes and enable common communication principles to be derived and applied to new disasters to reduce risk.

M4-K.4 Zwickle, A*; Wilson, RS; Michigan State University; zwickle.1@buckeyemail.osu.edu
Untangling the Various Effects of Psychological Distance

The use of psychological distance has shown promising ability to increase the success of risk communication efforts. This talk focuses on the complexities of applying psychological distance to the context of climate change. Applying psychological distance, an objective measurement, to climate change becomes problematic because individuals have varying perceptions of when, where, and to whom the impacts of a changing climate will occur. In a recent survey, we found that perceived psychological distance was highly correlated with the amount that individuals considered the risk of climate change to be personally relevant. This finding may complicate the interpretation of past results suggesting that concern for climate change decreases as psychological distance increases. Instead, it is possible that this lack of concern may also be attributed to the fact that one does not consider the risk to be personally relevant (as it is affecting other people in other places and times) rather than just psychologically distant. In order to isolate the effects of psychological distance we manipulated temporal distance, while holding the other dimensions constant, by measuring support for climate mitigation policies set in either the immediate or distant future. Results from this study suggest specific limitations for using psychological distance in any kind of risk communication. Namely, manipulating or measuring any dimension of psychological distance other than the temporal dimension will likely trigger other constructs, such as personal relevance. Our data also suggests that increasing psychological distance may help individuals make policy decisions that are more in line with their values and less influenced by temporal discounting. Developing a more accurate understanding of the true effects of psychological distance will help focus research efforts in risk communication and potentially contribute to the formulation of politically challenging climate mitigation policies.