

TECHNICAL SESSIONS

This year's Symposium & Workshop will offer a comprehensive technical program featuring 11 technical sessions and five short courses. Technical sessions will highlight research and innovative technologies that assist the Department of Defense (DoD) in addressing increasingly complex environmental and mission sustainability challenges.

The following list indicates when each technical session will occur and which short courses are taking place simultaneously. More information about each technical session, including a description of each session, an agenda, and abstracts, is available in the pages that follow. Following the Symposium, speaker presentations will be uploaded to the Symposium web site (www.serdp-estcp.org/symposium) for viewing by attendees.

TUESDAY AFTERNOON (1:45–5:00 p.m.)

Technical Session 1A – Field Applications of Advanced Diagnostic Tools

Technical Session 1B – Challenges Associated with Regional Predictions of Climate Change Impacts

Technical Session 1C – Emerging Contaminants – From Assessment to Action

Short Course 1 – Geophysical System Verification – Alternative to Geophysical Prove-Outs (GPO)

WEDNESDAY MORNING (8:30–11:45 a.m.)

Technical Session 2A – Amendments for Contaminated Sediments

Technical Session 2B – Classification Methods for Military Munitions Response (Part I)

Technical Session 2C – Environmentally Sustainable Energetics

Short Course 2 – Long-Term Monitoring Optimization

WEDNESDAY AFTERNOON (1:45–5:00 p.m.)

Technical Session 3A – Risk-Based Contaminant Management on Active Training Ranges

Technical Session 3B – Classification Methods for Military Munitions Response (Part II)

Technical Session 3C – DoD Greenhouse Gas Emissions: Land Use and the Installation Carbon Footprint

Technical Session 3D – Aircraft Emissions: Future Impacts and Alternative Fuels

THURSDAY MORNING (8:30–11:45 a.m.)

Technical Session 4A – Ecology and Management of DoD Coastal and Estuarine Ecosystems

Short Course 3 (all day) – Tools for Management of Chlorinated Solvent-Contaminated Sites

Short Course 4 (all day) – Visual Sample Plan – Unexploded Ordnance Module

THURSDAY AFTERNOON (1:00–5:00/5:30 p.m.)

Three concurrent short courses will occur. No technical sessions will take place.

| PRESENTER ORGANIZATION | TECHNICAL PRESENTATION TITLE | PAGE |
|--|--|-------------|
| TUESDAY AFTERNOON | | |
| Technical Session 1A – Field Applications of Advanced Diagnostic Tools | | |
| Description and Agenda | | C-1 |
| Dr. Allen Shapiro <i>U.S. Geological Survey</i> | Design, Implementation, and Monitoring of Groundwater Remediation: Recent Advances in Characterizing Heterogeneous Aquifer Properties and Biogeochemical Conditions | C-2 |
| Dr. Frank Loeffler <i>Georgia Institute of Technology</i> | Nucleic Acid-Based Quantification of <i>Dehalococcoides</i> in Groundwater | C-3 |
| Dr. Elizabeth Edwards <i>University of Toronto</i> | Stable Isotopes as Natural Reaction Probes in Bioremediation | C-4 |
| Dr. Douglas Mackay <i>University of California, Davis</i> | Mass Flux Measurements – A Comparison of Tools | C-5 |
| Ms. Kira Lynch <i>USEPA Region 10</i> | A Regulator’s Perspective on the Use of Mass Flux and Mass Discharge as a Performance Metric in CERCLA Decision Documents – Case Study of the Time Oil Well 12A Site | C-6 |
| Michael Kavanaugh, Ph.D., PE, BCEE <i>Malcolm Pirnie, Inc.</i> | <i>Keynote Address:</i> Diagnostic Tools for Performance Evaluation of In-Situ Technologies: Implementation, Performance, and Costs | C-7 |
| TUESDAY AFTERNOON | | |
| Technical Session 1B – Challenges Associated with Regional Predictions of Climate Change Impacts | | |
| Description and Agenda | | C-8 |
| Dr. Daniel Sarewitz <i>Arizona State University</i> | <i>Keynote Address:</i> Can Rationality Be Irrational? Science, Predictions, and Climate Change | C-9 |
| Dr. Jagadish Shukla <i>George Mason University Institute of Global Environment and Society</i> | On the Necessity and the Possibility of Improved Regional Predictions in a Changing Climate | C-10 |
| Dr. Robert Lempert <i>RAND Corporation</i> | Using Uncertain Regional Climate Forecasts to Inform Robust Decisions | C-11 |
| Dr. Casey Brown <i>University of Massachusetts</i> | Probabilistic Assessment of Climate Risks to Water Resource Systems | C-12 |
| Dr. David Revell <i>Philip Williams & Associates, Ltd.</i> | A Scenario-Based Approach to Evaluating Coastal Hazards as a Result of Sea Level Rise Along the California Coast | C-13 |
| TUESDAY AFTERNOON | | |
| Technical Session 1C – Emerging Contaminants – From Assessment to Action | | |
| Description and Agenda | | C-14 |
| Ms. Shannon Cunniff <i>ODUSD(I&E)</i> | <i>Keynote Address:</i> Processes for Identifying, Assessing and Managing Emerging Contaminants | C-15 |
| Mr. Bruce Sartwell <i>SERDP/ESTCP</i> | Hexavalent Chromium – Phase II Results, RMOs and Progress | C-16 |

| PRESENTER ORGANIZATION | TECHNICAL PRESENTATION TITLE | PAGE |
|--|--|-------------|
| Mr. Andrew Rak <i>Noblis</i> | SF6 & RDX: Phase II Results, RMOs and Research Needs | C-17 |
| Mr. Paul Yaroschak <i>Office of the Secretary of Defense</i> | Can Environmental Sustainability be Factored into DoD Acquisition Programs? | C-18 |
| Mr. Christopher Carroll <i>U.S. Army Center for Health Promotion and Preventive Medicine</i> | ESOH Risk Management Issues for R&D Workers | C-19 |
| WEDNESDAY MORNING <i>Technical Session 2A – Amendments for Contaminated Sediments</i> | | |
| Description and Agenda | | C-20 |
| Mr. Stephen J. Ells <i>U.S. Environmental Protection Agency</i> | <i>Keynote Address: Regulatory Issues on the Use of Amendments in Sediment Caps at Superfund Sites</i> | C-21 |
| Professor Upal Ghosh <i>University of Maryland Baltimore County</i> | Field Demonstration of Activated Carbon Amendment to Sediment in a River | C-22 |
| Dr. Anna Sophia Knox <i>Savannah River National Laboratory</i> | In Situ Remediation of Contaminated Sediments Using Sequestering Agents – Effects on Metal Bioavailability, Erosion, and Ecotoxicity | C-23 |
| Dr. Kevin Gardner <i>University of New Hampshire</i> | Reactive Mat Capping Performance | C-24 |
| Dr. Janet Thompson <i>U.S. Geological Survey</i> | Assessing Ecological Recovery: Sometimes the Question Is “Who Isn’t Here and Why?” | C-25 |
| Mr. John Haggard <i>General Electric-Corporate Environmental Programs</i> | Hudson River Dredging – Review of Year 1 Results | C-26 |
| WEDNESDAY MORNING <i>Technical Session 2B – Classification Methods for Military Munitions Response (Part I)</i> | | |
| Description and Agenda | | C-27 |
| Mr. Christopher Evans <i>U.S. Army Corps of Engineers, Baltimore District</i> | <i>Keynote Address: Challenges at MMRP Sites</i> | C-28 |
| Dr. Daniel Steinhurst <i>Nova Research, Inc.</i> | Former Camp San Luis Obispo: Site Description and Data Collection Overview | C-29 |
| Dr. Dean Keiswetter <i>SAIC</i> | EM61 and Magnetic Sensors: Application and Performance Summary at Former Camp San Luis Obispo | C-30 |
| Dr. Stephen Billings <i>Sky Research, Inc.</i> | Processing and Discrimination Strategies for Next- Generation EMI Sensor Data | C-31 |

| PRESENTER ORGANIZATION | TECHNICAL PRESENTATION TITLE | PAGE |
|--|---|-------------|
| WEDNESDAY MORNING | | |
| Technical Session 2C – Environmentally Sustainable Energetics | | |
| Description and Agenda | | C-32 |
| Mr. Anthony Melita <i>OUSD(AT&L)/PSA/LW&M</i> | <i>Keynote Address: Environmentally Sustainable Energetics – An OSD Perspective</i> | C-33 |
| Dr. Brian Roos <i>U.S. Army Research Laboratory</i> | Formulation of an Environmentally Benign Explosive | C-34 |
| Ms. Therese AtienzaMoore <i>Naval Air Warfare Center Weapons Division</i> | Navy IM/Green Energetics with a Focus on Propulsion Systems | C-35 |
| Mr. James Wejsa <i>ARDEC</i> | Insensitive Munitions for Pyrotechnics | C-36 |
| Ms. Kim Teal <i>US EPA Office of Air Quality Planning and Standards</i> | Status of the Revised National Ambient Air Quality Standards (NAAQS) for Lead | C-37 |
| Dr. Sarah Headrick <i>ATK Energetic Systems</i> | Development Toward the Removal of Lead from Military Applications | C-38 |
| WEDNESDAY AFTERNOON | | |
| Technical Session 3A – Risk-Based Contaminant Management on Active Training Ranges | | |
| Description and Agenda | | C-39 |
| Dr. Thomas Jenkins <i>Thomas Jenkins Environmental Consulting</i> | <i>Keynote Address: Residues of Energetic Compounds on DoD Training Ranges</i> | C-40 |
| Mr. Alan Hewitt <i>U.S. Army ERDC-CRREL</i> | Estimating the Surface Loading of Munitions Constituents (MC) on Military Training Ranges | C-41 |
| Dr. Susan Taylor <i>U.S. Army ERDC-CRREL</i> | Fate of Explosives on Range Soils | C-42 |
| Ms. Amy Hawkins <i>Naval Facilities Engineering Service Center</i> | Soil Properties, Metal Bioavailability and Risk Assessment | C-43 |
| Dr. Sonia Thiboutot <i>DRDC Valcartier</i> | Canadian Perspectives on Risk-Based Contaminant Management | C-44 |
| Mr. Harry D. Craig <i>U.S. EPA Region 10</i> | Regulatory Perspectives on Munitions Residues Site Characterization | C-45 |
| WEDNESDAY AFTERNOON | | |
| Technical Session 3B – Classification Methods for Military Munitions Response (Part II) | | |
| Description and Agenda | | C-46 |
| Ms. Stephanie Cappa <i>U.S. House of Representatives - Office of the Honorable Earl Blumenauer</i> | <i>Keynote Address: Unexploded Ordnance: A View from Capitol Hill</i> | N/A |
| Dr. Erika Gasperikova <i>Lawrence Berkeley National Laboratory</i> | BUD Cued Survey Results from San Luis Obispo, CA | C-47 |

| PRESENTER ORGANIZATION | TECHNICAL PRESENTATION TITLE | PAGE |
|---|--|-------------|
| Dr. Thomas Bell <i>Science Applications International Corporation</i> | Classification Performance with an Array of TEM Sensors at San Luis Obispo | C-48 |
| Dr. D.D. “Skip” Snyder <i>Snyder Geoscience, Inc.</i> | UXO Classification with Static-Mode Metalmapper ^(TM) Data from SLO | C-49 |
| Professor Lawrence Carin <i>Signal Innovations Group</i> | Active Supervised and Semi-Supervised Learning at SLO | C-50 |
| Dr. Herb Nelson <i>SERDP/ESTCP</i> | ESTCP Live Site Demonstration Program | C-51 |
| WEDNESDAY AFTERNOON <i>Technical Session 3C – DoD Greenhouse Gas Emissions: Land Use and the Installation Carbon Footprint</i> | | |
| Description and Agenda | | C-52 |
| Dr. Richard Birdsey <i>USDA Forest Service, Northern Research Station</i> | <i>Keynote Address:</i> The Potential Role of U.S. Military Lands in Reducing Carbon Dioxide Emissions and Increasing Carbon Sequestration | C-53 |
| Mr. Matthew Gray <i>U.S. Department of Energy</i> | Emerging Federal Framework for Greenhouse Gas Accounting | C-54 |
| Dr. Coeli Hoover <i>USDA Forest Service, Northern Research Station</i> | Estimating Carbon Sequestration on Military Lands: Methods and Case Studies | C-55 |
| Mr. Neil Sampson <i>The Sampson Group, Inc.</i> | Carbon Offset Accounting | C-56 |
| Dr. Beatrice Van Horne <i>U.S. Geological Survey</i> | The National Assessment of Current and Potential Greenhouse Gas Sequestration | C-57 |
| WEDNESDAY AFTERNOON <i>Technical Session 3D – Aircraft Emissions: Future Impacts and Alternative Fuels</i> | | |
| Description and Agenda | | C-58 |
| Professor Ian A. Waitz <i>MIT Department of Aeronautics and Astronautics</i> | <i>Keynote Address:</i> Environmental Impacts of Aircraft | C-59 |
| Dr. Robert Hancock <i>Air Force Research Laboratory-Propulsion Directorate</i> | Air Force Vision of Alternative Fuels and Fuel Efficient Engines | C-60 |
| Dr. Hukam Mongia <i>Purdue University</i> | Gas Turbine Engine Emissions Challenges with Alternative Fuels | C-61 |
| Dr. Med Colket <i>United Technologies Research Center</i> | Models for Predicting Soot Particulate Emissions from Combustors: Evolution, Status and Needs | C-62 |
| Mr. Edwin Corporan <i>Air Force Research Laboratory-Propulsion Directorate</i> | Combustion Emissions of Alternative Jet Fuels | C-63 |
| Dr. Scott Herndon <i>Aerodyne Research, Inc.</i> | Evolution of Aircraft Engine Emissions in the Atmosphere | C-64 |

| PRESENTER ORGANIZATION | TECHNICAL PRESENTATION TITLE | PAGE |
|---|--|-------------|
| THURSDAY MORNING <i>Technical Session 4A – Ecology and Management of DoD Coastal and Estuarine Ecosystems</i> | | |
| Description and Agenda | | C-65 |
| Dr. W. Michael Kemp <i>University of Maryland</i> | <i>Keynote Address: Chesapeake Bay Ecosystem: Decades of Degradation and a Road to Recovery?</i> | C-66 |
| Professor Hans W. Paerl <i>University of North Carolina at Chapel Hill, Institute of Marine Sciences</i> | Application of Advanced Indicators to Distinguish Military from Other Human and Climatic Impacts on Estuarine Ecosystem Function | C-67 |
| Dr. Charles Peterson <i>University of North Carolina at Chapel Hill, Institute of Marine Sciences</i> | Resilience of Ecosystem Services to Natural Physical Forcings vs. Human Interventions on a Coastal Barrier at Camp Lejeune Marine Corps Base | C-68 |
| Dr. James Morris <i>University of South Carolina</i> | Can Coastal Wetlands Survive a Higher Rate of Sea-Level Rise? | C-69 |
| Dr. Denise Reed <i>University of New Orleans</i> | Gulf Coast Wetlands and Sea-Level Rise: Giving Them a Fighting Chance | C-70 |
| J. Charles Fox <i>U.S. Environmental Protection Agency</i> | Restoring Chesapeake Bay | N/A |

TECHNICAL SESSION 1A

Topic: *Field Applications of Advanced Diagnostic Tools*

Chairs: Dr. Michael Kavanaugh and Dr. Rula Deeb, Malcolm Pirnie, Inc.

Keynote: Dr. Michael Kavanaugh

Advanced diagnostic tools, such as molecular biological tools (MBT) and compound-specific isotope analysis (CSIA), are increasingly being used at field sites to support remediation efforts. Recent research has explored how these tools can be used to improve remedial design and operation. This session will highlight technology advancements and their application to the design, performance, and monitoring of remedial systems.

| Session 1A - Field Applications of Advanced Diagnostic Tools | | |
|--|--|--|
| Time | Topic/Title | Speaker Organization |
| 1:45 – 1:55 PM | Welcome & Introduction by the Session Chairs | Dr. Michael Kavanaugh and Dr. Rula Deeb Malcolm Pirnie, Inc. |
| 1:55 – 2:20 PM | Design, Implementation, and Monitoring of Groundwater Remediation: Recent Advances in Characterizing Heterogeneous Aquifer Properties and Biogeochemical Conditions | Dr. Allen Shapiro U.S. Geological Survey |
| 2:20 – 2:45 PM | Nucleic Acid-Based Quantification of <i>Dehalococcoides</i> in Groundwater | Dr. Frank Loeffler Georgia Institute of Technology / School of Civil & Environmental Engineering |
| 2:45 – 3:10 PM | Stable Isotopes as Natural Reaction Probes in Bioremediation | Dr. Elizabeth Edwards University of Toronto / Department of Chemical Engineering & Applied Chemistry |
| 3:10 – 3:35 PM | BREAK | |
| 3:35 – 4:00 PM | Mass Flux Measurements – A Comparison of Tools | Dr. Douglas Mackay University of California, Davis / Department of Land, Air & Water Resources |
| 4:00 – 4:25 PM | A Regulator's Perspective on the Use of Mass Flux and Mass Discharge as a Performance Metric in CERCLA Decision Documents – Case Study of the Time Oil Well 12A Site | Ms. Kira Lynch U.S. EPA, Region 10 |
| 4:25 – 4:50 PM | KEYNOTE: Diagnostic Tools for Performance Evaluation of In-Situ Technologies: Implementation, Performance, and Costs | Michael Kavanaugh, Ph.D., PE, BCEE Malcolm Pirnie, Inc. |
| 4:50 – 5:00 PM | Discussion / Wrap-Up | |

DESIGN, IMPLEMENTATION, AND MONITORING OF GROUNDWATER REMEDATION: RECENT ADVANCES IN CHARACTERIZING HETEROGENEOUS AQUIFER PROPERTIES AND BIOGEOCHEMICAL CONDITIONS

DR. ALLEN SHAPIRO
U.S. Geological Survey
12201 Sunrise Valley Drive
Mail Stop 431
Reston, VA 20192
(703) 648-5884
ashapiro@usgs.gov

At sites of groundwater contamination, there is a strong temptation to rush to the design and implementation of remediation strategies based on simple conceptual models of aquifer properties and hydrogeologic conditions. The fate and transport of contaminants, including chlorinated solvents, metals, and other industrial compounds, depend heavily on physical and biogeochemical heterogeneity within the aquifer. Even the simplest of geologic environments can possess subtle variability in aquifer properties and biogeochemical conditions that can greatly affect the fate and transport of groundwater contaminants. Characterizing heterogeneity in aquifer properties and the spatial extent of contaminant plumes has evolved over the past decade with advances in methods of collecting water samples that can finely resolve spatially variable biogeochemical conditions. Methods have also been developed to collect aquifer materials that can be interrogated to provide insight into the pore scale processes affecting the fate of contaminants. Surface and in situ geophysical methods and improvements in the processing of geophysical data have also advanced over the past decade with methods that capture the three-dimensional variability of aquifer and fluid properties. Incorporating time-varying responses into geophysical surveys offers an approach that can potentially separate lithologic heterogeneity from fluid heterogeneity, providing evidence of plume migration and identifying the effects of in situ remediation. Methods using three-dimensional hydraulic responses and in situ testing using chemical tracers have been developed to estimate aquifer properties that are directly relevant in conceptualizing groundwater flow, chemical migration, and the design of remediation strategies. The application of these recent advances, however, becomes more powerful if an underlying geologic framework is used as a basis for data collection. The underlying geologic framework provides a starting point in conceptualizing the spatial persistence and connectivity of aquifer properties. The geologic framework provides a means of conditioning interpretations of the various data sets and extrapolating under conditions of sparse data.

NUCLEIC ACID-BASED QUANTIFICATION OF DEHALOCOCCOIDES IN GROUNDWATER

DR. FRANK LÖEFFLER
Georgia Institute of Technology
Environmental Engineering
311 Ferst Drive
Atlanta, GA 30332
(404) 894-0279
frank.loeffler@ce.gatech.edu

Bacteria of the *Dehalococcoides* (Dhc) group play a key role in the detoxification of chlorinated ethenes. While a variety of bacteria dechlorinate tetrachloroethene (PCE) and trichloroethene (TCE) to cis-1,2-dichloroethene (cis-DCE), the reductive dechlorination of DCEs and vinyl chloride (VC) to the innocuous ethene has been firmly linked to the presence and activity of Dhc bacteria. Documented successes of biostimulation and bioaugmentation with Dhc-containing consortia at contaminated sites have given bioremediation credibility as a viable in situ technology for achieving plume control and reducing source zone contaminant flux. To support the decision-making process for selecting the most efficient remedial technology (e.g., monitored natural attenuation or biostimulation with/without bioaugmentation) and for monitoring the progress of bioremediation, molecular biological tools (MBTs) that specifically target Dhc nucleic acids have been designed. MBTs monitor Dhc biomarker gene abundance over temporal and spatial scales and provide useful information about the progress and performance of the reductive dechlorination process, especially when analyzed in conjunction with contaminant data and geochemical parameters.

Currently used Dhc biomarker gene targets for monitoring Dhc presence and abundance rely on the 16S rRNA gene and three dehalogenase genes (i.e., *tceA*, *vcrA* and *bvcA*) implicated in the reductive dechlorination of chlorinated ethenes. Nucleic acids are typically obtained from groundwater samples collected from suitable monitoring wells. To generate information about Dhc biomarker gene abundance, the method of choice is quantitative real-time PCR (qPCR). The qPCR data are used for site assessment and bioremediation monitoring, and to support the decisions on technology selection.

To increase confidence in the microbial MBT data, a systematic evaluation of the key steps leading from the environmental sample to quantitative information of Dhc abundance is being conducted under the auspices of SERDP- and ESTCP-funded projects. The key goals are to design a comprehensive suite of Dhc biomarker targets along with sampling and analysis procedures that generate information about the true abundance and activity of Dhc bacteria in contaminated aquifers. The challenges in interpreting Dhc DNA and RNA (i.e., transcript) biomarker data will be discussed and brought into context for making site management decisions.

STABLE ISOTOPES AS NATURAL REACTION PROBES IN BIOREMEDIATION

DR. ELIZABETH EDWARDS
University of Toronto
Department of Chemical Engineering & Applied Chemistry
200 College Street
Toronto, ON M5S 3E5 CANADA
(416) 976-3506
elizabeth.edwards@utoronto.ca

CO-PERFORMER: Barbara Sherwood Lollar

Compound specific stable isotope fractionation in combination with careful analyses of contaminant transformation reaction substrates and products in microbial systems can provide a very useful way to explore novel metabolic pathways and constrain reaction mechanisms. Several examples of the application of stable isotope fractionation to investigate biodegradation pathways will be provided.

MASS FLUX MEASUREMENTS – A COMPARISON OF TOOLS

DR. DOUGLAS MACKAY
University of California, Davis
Department of Land, Air and Water Resources
Davis, CA 95616
(650) 324-2809
dmmackay@ucdavis.edu

CO-PERFORMERS: M. Einarson (AMEC Geomatrix Consultants); Dr. P. Kaiser, Dr. M. Nozawa-Inoue, and S. Gurushinge (formerly UC Davis); Dr. S. Goyal, Dr. K. Scow, I. Chakraborty, and E. Rasa (UC Davis); Dr. M. Annable and Dr. K. Hatfield (U. Florida); Dr. M. Goltz (Air Force Inst. Tech.); Dr. J. Huang (formerly Air Force Inst. Tech); Dr. M. Brooks and Dr. L. Wood (EPA); Dr. M. Kavanaugh, Dr. R. Deeb, and E. Hawley (Malcolm Pirnie)

Contaminant mass discharge (a.k.a. total mass flux) is defined as the total amount of contaminant mass migrating within groundwater past some plane of reference perpendicular to groundwater flow. We tested different measurement methods by applying them to an experimentally created bromide tracer plume: (1) Synoptic (“snapshot”) sampling of wells in transects; (2) Steady-state pumping (SSP) of wells in transects; (3) Deployment of passive flux meters (PFMs) in wells in transects; and (4) Recirculation flux measurement (RFM) using pairs of wells in transects. Our target plume was created by controlled injection of groundwater spiked with bromide tracer and we had extremely dense transects of sampling wells arrayed perpendicular to flow sampled unusually frequently. Thus we had atypical insights into the true bromide mass discharge, the groundwater flow rate, etc. We utilized the extensive bromide data set to refine our characterization of the flowfield and the aquifer, as well as to estimate the bromide mass discharge over time and the total cumulative bromide mass passing the monitoring transects. Although not typically possible, this allowed us to define a “true” or “calibrated” value of bromide mass discharge by Method 1 at each transect for each sampling time. Accuracy of Methods 2-3 were determined by comparison to the calibrated results of Method 1 and results of calibrated computer modeling. Method 4 could not be evaluated during the demonstration due to errors in application. Method 3 (PFM) was found to be accurate and precise. Method 2 (SSP) was found to have a significant negative bias in our demonstration, but would be expected to be quite accurate and precise if more optimal initial design were possible (better estimates of hydraulic conductivity) or if the method were conducted in steps of increasing extraction rate. We evaluated the probable performance of Methods 1 and 3 in more typical situations, i.e. with fewer wells and less knowledge of the hydrogeology and contaminant distribution. We found that accuracy and precision of Method 1 (and by analogy Method 3) depended on the spacing of the wells in the transect and also the location of the wells with respect to the plume. The precision of such methods depends on interwell spacing compared to the widths of the high concentration portions of the plume; precision is good if the ratio is less than one. In this talk we will highlight some advantages and disadvantages of each method and identify major knowledge gaps.

A REGULATOR'S PERSPECTIVE ON THE USE OF MASS FLUX AND MASS DISCHARGE AS A PERFORMANCE METRIC IN CERCLA DECISION DOCUMENTS – CASE STUDY OF THE TIME OIL WELL 12A SITE

MS. KIRA LYNCH
USEPA REGION 10
1200 Sixth Avenue
Mail Code: ECL-113
Seattle, WA 98101
(206) 553-2144
lynch.kira@epa.gov

Many CERCLA decision documents for DNAPL site remediation lack clear remedial action objectives for determining and documenting when sufficient source treatment has been completed. Mass flux and mass discharge can be used as a performance metric in decision documents to document when source treatment is considered “complete” and long-term groundwater restoration projects can be considered operational and functional. In addition, mass flux and mass discharge measurements can be used to help characterize sites and refine the site conceptual model so that remedial options can be optimized. However, mass flux and mass discharge measurements can be expensive and accurate measurements require site managers to have a good understanding of groundwater flow and hydraulic conductivity. Further, many EPA and State regulators are not familiar with setting groundwater remedial goals that are not concentration based estimates, and how mass flux and mass discharge goals can be utilized in long-term plume management strategies with remedial action objectives goals of meeting Maximum Contaminant Levels (MCLs). This presentation will discuss the advantages and drawbacks of utilizing mass flux and mass discharge to assist with the characterization, design and performance assessment of remedial actions from a regulator’s perspective. In addition, this presentation will also present a case study (Time Oil Well 12A Site) where mass flux and mass discharge were used as a performance metric.

KEYNOTE ADDRESS
**DIAGNOSTIC TOOLS FOR PERFORMANCE EVALUATION OF IN-SITU
TECHNOLOGIES: IMPLEMENTATION, PERFORMANCE, AND COSTS**

MICHAEL KAVANAUGH, PH.D., PE, BCEE
Malcolm Pirnie, Inc.
2000 Powell Street, Suite 1180
Emeryville, CA 94608
(510) 735-3010
mkavanaugh@pirnie.com

CO-PERFORMERS: Dr. Rula Deeb, Daria Navon, and Kenneth Goldstein (Malcolm Pirnie, Inc.); Dr. Beth Parker (University of Guelph); Dr. John Cherry (University of Waterloo); Dr. Kent Sorenson and Dr. Tamzen Macbeth (CDM); Dr. Lisa Alvarez-Cohen (University of California at Berkeley); Dr. Douglas Mackay (University of California at Davis); Murray Einarson (Einarson and Associates); Dr. Mark Goltz (Air Force Institute of Technology); Dr. Michael Annable and Kirk Hatfield (University of Florida)

The performance of remediation systems at chlorinated solvent contaminated sites has been historically evaluated using point measurements of dissolved contaminant concentrations in aquifers (e.g., changes in maximum concentrations, plume extent, etc.). Such an approach has significant limitations that may greatly impact the evaluation of technology effectiveness at contaminated sites. First, detailed monitoring conducted of contaminant plumes in granular geologic media has shown that the distribution of dissolved contaminants is often spatially complex due to several factors including spatial variability of contaminant distribution in the subsurface source zone, variability of groundwater flow rate and direction, and variation in water level. This means that it may often be difficult to impossible for typical groundwater monitoring efforts, especially those relying on sparse networks of long-screened wells, to determine where the majority of the contaminant mass is migrating and therefore whether remediation systems are effective in reducing contaminant migration. Second, at sites with complex geologies such as fractured rock sites, the evaluation of in-situ technology performance is even more complicated by contaminant migration through discrete fractures.

To better evaluate the success of in-situ remedial systems at chlorinated solvent contaminated sites, a set of diagnostic tools was used at three hydrogeologically distinct sites employing in-situ chemical and biological treatment technologies over the past several years. These diagnostic tools include technology- and geology-specific tools, as well as those that can be used widely irrespective of the type of technology or site conditions. Mass flux measurement was used as a technology-wide metric of overall system performance since it has the potential to clearly demonstrate a reduction in the rate of contaminant mass release from the treated zone. Innovative technology-specific tools (e.g., molecular tools for in-situ bioremediation) and geology-specific tools (e.g., rock crushing at fractured bedrock sites) were tested for a real-time diagnosis of remedial technology success. Technology- and geology-specific tools evaluated in this study included rock core sampling, isotopic fractionation, molecular tools and integrated conventional techniques. This presentation will summarize the findings of ESTCP project ER-0318 and will detail the performance and cost of four sets of diagnostic tools: (1) depth discrete sampling, (2) mass flux measurement tools, (3) stable carbon isotope sampling, and (4) molecular tools.

TECHNICAL SESSION 1B

Topic: *Challenges Associated with Regional Predictions of Climate Change Impacts*

Chair: Dr. Christopher Weaver, U.S. Environmental Protection Agency – Global Change Research Program

Keynote: Dr. Daniel Sarewitz, Arizona State University – Consortium for Science, Policy & Outcomes

This session will address the current state of theory and practice for incorporating information about potential, but potentially highly uncertain, future climate change projections and impacts into the regional and installation management and planning decisions of relevance to DoD, with a particular emphasis on water resources and coastal protection. Two paradigms will be presented that are currently used as frameworks for informing decision making and adaptation strategies: (1) probabilistic forecasting with predict-then-act strategies and (2) scenario-based approaches that identify the greatest vulnerabilities and policy trade-offs across the broadest possible range of plausible futures. The session will conclude with a panel discussion.

| Session 1B - Challenges Associated with Regional Predictions of Climate Change Impacts | | |
|--|--|---|
| Time | Topic/Title | Speaker Organization |
| 1:45 – 1:55 PM | Welcome & Introduction by the Session Chair | Dr. Christopher Weaver U.S. Environmental Protection Agency / Global Change Research Program |
| 1:55 – 2:20 PM | KEYNOTE: Can Rationality be Irrational?: Science, Predictions, and Climate Change | Dr. Daniel Sarewitz Arizona State University, Consortium for Science, Policy & Outcomes |
| 2:20 – 2:45 PM | On the Necessity and the Possibility of Improved Regional Predictions in a Changing Climate | Dr. Jagadish Shukla George Mason University Institute of Global Environment and Society |
| 2:45 – 3:10 PM | Using Uncertain Regional Climate Forecasts to Inform Robust Decisions | Dr. Robert Lempert RAND Corporation |
| 3:10 – 3:35 PM | BREAK | |
| 3:35 – 4:00 PM | Probabilistic Assessment of Climate Risks to Water Resource Systems | Dr. Casey Brown University of Massachusetts, Department of Civil and Environmental Engineering |
| 4:00 – 4:25 PM | A Scenario Based Approach to Evaluating Coastal Hazards as a Result of Sea Level Rise Along the California Coast | Dr. David Revell Philips Williams & Associates, Ltd. |
| 4:25 – 4:50 PM | Panel Discussion | |
| 4:50 – 5:00 PM | Discussion / Wrap-Up | |

KEYNOTE ADDRESS
**CAN RATIONALITY BE IRRATIONAL? SCIENCE, PREDICTIONS,
AND CLIMATE CHANGE**

DANIEL SAREWITZ
Arizona State University
Consortium for Science, Policy, and Outcomes
1701 K St., NW, Suite 301
Washington, DC 20006
(292) 446-0384
dsarewitz@asu.edu

Because decision making is inherently forward-looking, models of rationality would seem to imply that effective decision making can be aided by scientifically sound predictions. Moreover, science itself is often defined as a predictive enterprise, and reducing the uncertainty of scientific predictions is an oft-articulated goal of decision-relevant science. These ideas have been strongly embraced in policy approaches to climate change; indeed, predictions about the future of climate are central to the scientific and public framings of the climate problem. This presentation will discuss the limits of scientific predictions as a decision support tool, the role of predictions in the scientific enterprise, and the deeply problematic application of scientific predictions to climate policy. The presenter will offer guidelines for the appropriate application of predictions to decision making; almost all of these guidelines are violated in the case of climate change.

ON THE NECESSITY AND THE POSSIBILITY OF IMPROVED REGIONAL PREDICTIONS IN A CHANGING CLIMATE

DR. JAGADISH SHUKLA
George Mason University
Institute of Global Environment and Society
4041 Powder Mill Road
Suite 302
Calverton, MD 20705
(301) 595-7000
shukla@cola.iges.org

The impending threat of global climate change and its regional impacts are among the most important and urgent problems facing humanity. To adapt to and to cope with the dire consequences of climate change, global society will require accurate, reliable and quantitative prediction of regional climate variations. This presentation argues that it is both necessary and possible to develop and build accurate and advanced models for climate prediction so that reliable and quantitative predictions of regional climate change can be provided to global society for science-based adaptation strategies.

This presentation further argues that, because of the complexity of the climate system, and because the regional manifestations of climate change are mainly through changes in the statistics of regional weather variations, the scientific and computational requirements to predict its behavior reliably are so enormous that the nations of the world should make the dual commitments of enhancing their national climate modeling efforts and creating a small number of multi-national research and high performance computing facilities dedicated to the grand challenges of predicting climate change on both global and regional scales over the coming decades.

Motivated by the success of internationally-funded infrastructure in other areas of science, it is recommended that a small number of highly connected multi-national facilities should have computer capability at each facility of about 20 petaflop in the near future and about 200 petaflop by the end of the next decade. Such facilities will enable future IPCC assessment to be made using about 10 km resolution climate models, and dynamical seasonal predictions using 3-5 km cloud system resolving atmosphere models and eddy revolving ocean models. This will also enable weather-climate modeling and prediction research using about 1 km resolution atmosphere models and about 5 km ocean models. Each facility should have enabling infrastructure including hardware, software and data analysis support, and scientific capacity.

Such facilities will play a key role in the development of next generation climate models, build global capacity, nurture a highly trained workforce, and engage the global user community, policymakers and stakeholders.

USING UNCERTAIN REGIONAL CLIMATE FORECASTS TO INFORM ROBUST DECISIONS

DR. ROBERT LEMPert
RAND Corporation
1776 Main Street
Santa Monica, CA 90407
(310) 393-0411, Ext. 6217
lempert@rand.org

Climate change will affect many organizations' ability to achieve their environmental and other goals. In response, many decision makers are using regional climate projections to inform their efforts to adapt to a changing climate. But the unavoidable uncertainty in such projections presents a significant challenge. Some organizations have used scenarios to provide climate information while others are beginning to use probabilistic climate forecasts. This talk will compare the strengths and weaknesses of these alternative approaches for incorporating uncertain regional climate information in decision-making and will argue that neither scenario nor probabilistic approaches are adequate as commonly employed. Rather than use such scenarios or probabilistic forecasts in a predict-then-act decision framework—which characterizes uncertainty separate from and prior to estimating the consequences of alternative decisions—decision-makers should consider a vulnerability and response option analysis decision framework that uses climate scenarios to highlight the tradeoffs among alternative decisions. This latter approach can help decision makers craft adaptation plans robust to the unavoidable uncertainty in climate projections. This talk describes how DoD and other government agencies might implement such an approach to providing climate information and some of the challenges involved.

PROBABILISTIC ASSESSMENT OF CLIMATE RISKS TO WATER RESOURCE SYSTEMS

DR. CASEY BROWN
University of Massachusetts
12B Marston Hall
130 Natural Resources Road
Amherst, MA 01002
(413) 577-2337
cbrown@ecs.umass.edu

There is growing concern that water resource systems are vulnerable to climate variability and climate change. The projected impacts of climate change, in particular, have extraordinary implications for most water resource systems. As a result, water resource managers and policy makers seek the best possible sources of climate change projections and information to assist their decision making needs. However, there is lack of an accepted framework for incorporating climate information, with its inherent uncertainties and limitations, into the decision making and policy processes of most institutions. As a result, the typical analysis follows the climate modelers' pathway of physical processes producing information that is often costly to produce and of limited value to decision makers. In this demonstration we propose and demonstrate a risk-based framework for the analysis of climate impacts on water resources systems. Risk-based approaches are gaining traction in the field of integrated assessment of climate change impacts as a result of a growing recognition of the irreducible uncertainties associated with climate change. The process proposed here builds from this work to develop a framework that is designed specifically for water resource systems and related infrastructure. It consists of three steps. The first step is a climate sensitivity analysis that is conducted based on past climate impacts and identification of the system vulnerabilities. The second step uses modeling to develop a "climate response function" that characterizes the response of the system to a given climate perturbation. The third step uses decision-scaling to tailor climate information to the climate response function to produce probabilistic estimates of climate risks. The framework will be illustrated with examples from actual water resource systems. Next, a strategy for managing climate risks will be discussed. The strategy focuses on dynamic management of the changing nature of climate to address risks that we can only partially anticipate. The resultant climate risk assessment and management approach is advocated for addressing future uncertainties in water resources planning and design.

A SCENARIO-BASED APPROACH TO EVALUATING COASTAL HAZARDS AS A RESULT OF SEA LEVEL RISE ALONG THE CALIFORNIA COAST

DR. DAVID REVELL
Philip Williams and Associates (PWA)
550 Kearny Street, Suite 900
San Francisco, CA 94108
(415) 262-2312
d.revell@pwa-ltd.com

CO-PERFORMER: Robert Battalio, P.E. (PWA)

Climate-induced sea level rise is expected to increase the extent of flooding- and erosion-related coastal hazards along the California coast. As a result of Governor Arnold Schwarzenegger's executive order, California state agencies have been asked to evaluate these potential impacts, as part of a suite of statewide activities to prepare for climate change and develop adaptation plans to enhance human and ecosystem resilience.

This presentation provides an overview of current sea level rise planning in California and focuses on a particular scenario-based assessment of potential erosion impacts in central and northern California for a range of planning horizons. This study was completed at a 500m scale, one appropriate for planning parcel-level decision making. Previous studies of sea level rise have relied on simplistic assumptions of physical processes and coastal landforms primarily based on the East Coast experience. To more accurately account for the range of geology, and geomorphology inherent on the tectonically active West Coast, a more sophisticated modeling approach that forecasts erosion from a downscaled regional climate model was developed. Building on the best currently available geospatial information on topography, erosion rates, failure mechanisms, and sea level rise scenarios, historic shoreline changes were estimated across the range of backshore types and geologic units. Erosion impacts were predicted based on increases in the total water levels attacking the base of the backshore.

This erosion assessment provided the technical input to a vulnerability assessment, which identified vulnerabilities in several military installations and critical transportation corridors, as well as in large areas of civilian development. Implications for appropriate adaptation strategies, and site-specific examples of current planning efforts as well as suggestions for improving the confidence in the models by applying a multiple scenario approach will be discussed.

TECHNICAL SESSION 1C

Topic: *Emerging Contaminants – From Assessment to Action*

Chairs: Dr. Rominder Suri, Temple University – Water and Environmental Technology Center and Ms. Shannon Cunniff, U.S. Department of Defense – Chemical and Material Risk Management Directorate

Keynote: Ms. Shannon Cunniff

This session will provide an overview of current emerging contaminant issues relevant to the research, development, and testing communities. The processes DoD uses to identify and assess its interests in and options for proactive management of emerging contaminants will be described. Specific risk management options—focusing on research needs—will be discussed for several emerging contaminants, including hexavalent chromium, sulfur hexafluoride, RDX, and nanomaterials. Criteria developed to enhance understanding of risks from new materials and chemicals lacking EPA toxicity values also will be presented. Time will be allocated for audience dialogue on expanding effective communication on emerging contaminant issues.

| Session 1C - Emerging Contaminants – From Assessment to Action | | |
|--|---|---|
| Time | Topic/Title | Speaker Organization |
| 1:45 – 1:55 PM | Welcome & Introduction by the Session Chairs | Dr. Rominder Suri Temple University / Water and Environmental Technology Center Ms. Shannon Cunniff U.S. Department of Defense / Chemical and Material Risk Management Directorate |
| 1:55 – 2:20 PM | KEYNOTE: Processes for Identifying, Assessing and Managing Emerging Contaminants | Ms. Shannon Cunniff U.S. Department of Defense / Chemical and Material Risk Management Directorate |
| 2:20 – 2:45 PM | Hexavalent Chromium: Phase II Results, RMOs and Progress | Mr. Bruce Sartwell SERDP/ESTCP |
| 2:45 – 3:10 PM | SF6 & RDX: Phase II Results, RMOs and Research Needs | Mr. Andrew Rak Noblis, Inc. |
| 3:10 – 3:35 PM | BREAK | |
| 3:35 – 4:00 PM | Can Environmental Sustainability be Factored into DoD Acquisition Programs? | Mr. Paul Yaroschak U.S. Department of Defense / Chemical and Material Risk Management Directorate |
| 4:00 – 4:25 PM | ESOH Risk Management Issues for R&D Workers | Mr. Christopher Carroll U.S. Army Center for Health Promotion and Preventive Medicine |
| 4:25 – 4:50 PM | Audience Discussion: How to Expand Effective Communication with the R&D Community on Current and Future Emerging Contaminants -- Gathering Intel on the Next Emerging Contaminant and Developing Technology Related Risk Management Options | Mr. David Asiello U.S. Department of Defense |
| 4:50 – 5:00 PM | Discussion / Wrap-Up | |

KEYNOTE ADDRESS
**PROCESSES FOR IDENTIFYING, ASSESSING AND MANAGING EMERGING
CONTAMINANTS**

MS. SHANNON CUNNIFF
ODUSD (I&E)
1225 S. Clark Street, Suite 1500
Arlington, VA 22202
(703) 604-1529
shannon.cunniff@osd.mil

The new Chemical and Materials Risk Management office focuses on protecting people and readiness by managing risks from emerging contaminants and known hazardous materials used by the Department of Defense (DoD). Its Scan – Watch – Action Process first identifies chemicals of interest to DoD, then assesses the environmental, safety, health and mission risks associated with likely regulatory shifts, and finally develops options to best manage the highest risks. Development of risk management options involves careful consideration of the technical feasibility, costs and benefits, payback period, likelihood of acceptance and implementation, and identification of an “owner.” After considerable evaluation and vetting, risk management options are presented to an enterprise board for endorsement. Numerous risk management measures have been developed, approved, and are underway. Engineered nanomaterials, perchlorate, RDX, hexavalent chromium, beryllium, and naphthalene are among the chemicals for which DoD has taken risk management actions in advance of foreseen shifts in regulation. This presentation will provide an overview of processes and tools used to identify emerging contaminants and to develop appropriate risk management options that enjoy enterprise support. Additionally, a few cross-cutting efforts to develop guidance and tools to manage the Department’s chemical and material risks will also be highlighted. This session lays the foundation for material presented by subsequent speakers.

HEXAVALENT CHROMIUM – PHASE II RESULTS, RMOs AND PROGRESS

MR. BRUCE SARTWELL
SERDP/ESTCP
901 N. Stuart Street, Suite 303
Arlington, VA 22203
(703) 696-2128
bruce.sartwell@osd.mil

CO-PERFORMER: Keith Legg (Rowan Technology Group)

Chemical compounds containing chromium in the hexavalent state (CrVI) are widely used on DoD weapons systems to impart corrosion resistance and enhance adhesion of coatings. However, CrVI is a known carcinogen and its use is highly regulated. In 2006, OSHA reduced the Permissible Exposure Limit (PEL) by an order of magnitude but it was widely recognized that there was a significant continued risk to workers exposed to CrVI even at the new level. International regulations are imposing greater restrictions on the use of CrVI compounds and this will undoubtedly affect material availability and continued usage within DoD.

The Chemical and Material Risk Management Directorate (CMRMD) has placed CrVI on its Action List, conducting a risk assessment and developing a Risk Management Plan, including Risk Management Options (RMOs). Five RMOs were approved: (1) Issue a policy aimed at minimizing use of CrVI on weapons systems, platforms and in DoD facilities, (2) Develop an accelerated corrosion test protocol that would better enable qualification of alternative materials, (3) Identify all applications where CrVI substitutes have been proven through testing and in-field use, (4) Conduct a study to document the status of qualification and implementation of alternatives, and (5) Develop and maintain a data base of lab and in-service test results, specifications and approvals. Related to (1), the Undersecretary of Defense for Acquisition, Technology and Logistics issued a Memorandum on Minimizing the Use of Hexavalent Chromium on April 8, 2009.

This presentation will describe the Risk Management Plan and discuss execution of the RMOs. The current status of research, development, test and evaluation related to replacing CrVI compounds on weapons systems will be described. Finally, the development of a data base as indicated in RMO #5 under a SERDP-ESTCP initiative designated ASETSDefense will be described.

SF6 & RDX: PHASE II RESULTS, RMOs AND RESEARCH NEEDS

MR. ANDREW RAK
Noblis
3150 Fairview Park Drive South
Falls Church, VA 22042
(703) 610-2166
andrew.rak@noblis.org

CO-PERFORMERS: Catherine M. Vogel and Michael C. Simmons (Noblis)

Sulfur hexafluoride (SF6) and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) are two very important yet very different emerging chemicals of critical importance to the Department of Defense (DoD). SF6 is an inert gas used in a variety of high energy electrical applications that is also a potent greenhouse gas. RDX is a solid high explosive used in many munitions items and may cause significant groundwater problems if released to the environment. Both chemicals were the subject of Phase II Impact Assessments to examine the potential impacts to the DoD from changes in regulations/toxicity values and develop risk management options (RMOs) to mitigate those potential impacts. SF6 is the subject of potential increasing regulation as part of growing state and federal efforts to control greenhouse gas emissions. RDX is the subject of potential changes in the toxicity values that are the basis of wastewater, drinking water, and remedial standards. The Phase II Impact Assessments identified potential risks to the DoD across five areas—environment safety and health; readiness and training; early research and acquisition; production, operations and maintenance; and remediation. Potential high risks from future changes in regulations for SF6 and RDX were identified in most of the evaluation areas. Risks to the readiness and training evaluation area are of particular concern. Given the critical role these two chemicals serve in several national defense weapon systems, RMOs to mitigate the anticipated risks were developed for endorsement by DoD senior leadership. The presentation will review the results of the Phase II Impact Assessments for SF6 and RDX and review the RMOs that were developed. Specifically, the RMOs requiring research and development activities will be highlighted.

CAN ENVIRONMENTAL SUSTAINABILITY BE FACTORED INTO DoD ACQUISITION PROGRAMS?

MR. PAUL YAROSCHAK
Office of the Secretary of Defense
1225 S. Clark Street
Arlington, VA 22202
(703) 604-0641
paul.yaroschak@osd.mil

Current DoD acquisition policies focus on Environmental, Safety & Occupational Health (ESOH) hazard identification and mitigation. Much of this effort takes place just prior to and in order to achieve a “green light” for Milestone B in the acquisition process. Requirements established for new DoD weapons systems and platforms are necessarily geared to meeting performance requirements. Program managers are focused on performance, cost, and schedule.

However, early in the technology development, Analysis of Alternatives, and Systems Engineering phases, critical choices are made regarding chemicals and materials that will be used throughout the system’s life cycle. These choices can affect human health and the environment for many years. Too often, these choices are made without a robust analysis of alternatives, life-cycle costs, and sustainability factors.

For example, DoD does not have detailed criteria for what chemical, physical, and toxicity data should be obtained for chemicals and materials being developed and specified in DoD acquisition programs. In other words, what do you need to know about a chemical or material and at what milestone in the DoD acquisition do you need to have certain data? The Chemical & Material Risk Management Directorate in the Office of the Secretary of Defense recently initiated a project to develop such criteria. The project consisted of four parts:

- Benchmarking existing guidance, policy, and practices worldwide.
- Developing a standard set of physical, chemical, and toxicological data needs.
- Identifying critical points in the DoD acquisition process requiring specific data.
- Developing guidance for DoD acquisition community.

The first three parts have been completed and the fourth is under development. This presentation will describe the results of the benchmarking, the specific criteria being considered, and how the criteria overlay on acquisition milestones. It will also explore the concept of analyzing a broader scope of environmental sustainability factors early in the acquisition process. The idea is to make better informed, more sustainable choices in chemicals and materials early in the process. Hazards, and thus mitigation of hazards, can be reduced by wise choices that still meet performance requirements.

ESOH RISK MANAGEMENT ISSUES FOR R&D WORKERS

MR. CHRISTOPHER CARROLL

U.S. Army Center for Health Promotion and Preventive Medicine

ATTN: MCHB-TS-OFS (Chris Carroll)

APG-EA, MD 21010

(410) 436-5465

chris.carroll@us.army.mil

Engineered nanomaterials are gaining in commercial application and governments and private sectors are actively researching their potential for use in various products and applications. As with most everyone else in the world, DoD is expected to increasingly use commercially available products using nanotechnology or that are nano-enabled or contain engineered nanomaterials. The various services and agencies within DoD are also spending a great deal of money in nanotechnology R&D to improve military effectiveness and soldier survivability. DoD investments in these advanced technologies are essential to maintaining the technological edge that U.S. forces will continue to depend on in the future for success on the battlefield and for protecting our homeland security.

Though enhanced or significantly different physical-chemical properties of nanoscale particles may be exploited to make new and improved materials, they may also result indirectly in materials whose health and environmental effects may differ from that of larger particles of identical chemical composition. It is therefore essential that we be aware that there may be differences in health and environmental impact and that we properly anticipate, recognize, evaluate, control and manage any risks that may be associated with the use of such materials.

TECHNICAL SESSION 2A

Topic: *Amendments for Contaminated Sediments*

Chair: Dr. Charles Menzie, Exponent, Inc.

Keynote: Mr. Stephen Ells, U.S. Environmental Protection Agency – Office of Superfund Remediation and Technology Innovation

While traditional capping techniques are a less invasive approach to sediment remediation, they do not address the concern of reducing contaminant mass. Active approaches to sediment capping technologies have been demonstrated that are capable of sequestering and degrading contaminants in situ through the application of amendments. This session will examine the use of amendments and amended capping as a contaminated sediment management tool and present recent advancements in understanding biological and chemical processes in treated sediments.

| Session 2A - Amendments for Contaminated Sediments | | |
|--|--|---|
| Time | Topic/Title | Speaker Organization |
| 8:30 – 8:40 AM | Welcome & Introduction by the Session Chair | Dr. Charles Menzie Exponent, Inc. |
| 8:40 – 9:05 AM | KEYNOTE: Regulatory Issues on the Use of Amendments in Sediment Caps at Superfund Sites | Mr. Stephen Ells U.S. Environmental Protection Agency / Office of Superfund Remediation and Technology Innovation |
| 9:05 – 9:30 AM | Field Demonstration of Activated Carbon Amendment to Sediment in a River | Professor Upal Ghosh University of Maryland, Baltimore County / Department of Civil and Environmental Engineering |
| 9:30 – 9:55 AM | In Situ Remediation of Contaminated Sediments Using Sequestering Agents - Effects on Metal Bioavailability, Erosion, and Ecotoxicity | Dr. Anna Sophia Knox Savannah River National Laboratory |
| 9:55 – 10:20 AM | BREAK | |
| 10:20 – 10:45 AM | Reactive Mat Capping Performance | Dr. Kevin Gardner University of New Hampshire / Civil Engineering |
| 10:45 – 11:10 AM | Assessing Ecological Recovery: Sometimes the Question Is “Who Isn’t Here and Why?” | Dr. Janet Thompson U.S. Geological Survey |
| 11:10 – 11:35 AM | Hudson River Dredging – Review of Year 1 Results | Mr. John Haggard General Electric-Corporate Environmental Programs |
| 11:35 – 11:45 AM | Discussion / Wrap-Up | |

KEYNOTE ADDRESS

**REGULATORY ISSUES ON THE USE OF AMENDMENTS IN SEDIMENT CAPS AT
SUPERFUND SITES**

MR. STEPHEN J. ELLS

U.S. Environmental Protection Agency

1200 Pennsylvania Avenue, N.W.

US EPA, OSRTI, 5204P

Washington, DC 20460

(703) 603-9112

Ells.Steve@epamail.epa.gov

At contaminated sediment Superfund sites, it is a continuing challenge to select remedies that control sources, achieve long-term protection, minimize short-term impacts, and are cost-effective. EPA's 2005 Contaminated Sediment Remediation Guidance for Hazardous Waste Sites recognizes the use of in situ treatment alternatives as a remedial approach, but provides very little information on this approach. The Guidance provides a chapter on each of the established remedial alternatives: monitored natural recovery (MNR), in situ capping, and dredging and excavation. Also, the Guidance lists site conditions especially conducive to dredging, capping, or MNR and discusses the advantages and limitations of each. This presentation discusses the types of data and information that may be needed in order for proposed remedies relying on in situ amendments to be evaluated in the context of the National Contingency Plan and ultimately to obtain regulatory acceptance. Some potential advantages of the use of in-situ amendments compared to other active remedial approaches will also be discussed.

FIELD DEMONSTRATION OF ACTIVATED CARBON AMENDMENT TO SEDIMENT IN A RIVER

PROFESSOR UPAL GHOSH
University of Maryland Baltimore County
1000 Hilltop Circle
Baltimore, MD 21042
(410) 455-8665
ughosh@umbc.edu

CO-PERFORMERS: Barbara Beckingham, Adam Grossman, and Jennifer Jerschied (UMBC)

In our recent work, we demonstrated how sediment geochemistry can be altered by the amendment of sorbents, such as activated carbon, to reduce contaminant availability, exposure, and accumulation in sediment-dwelling organisms. Results of a field demonstration study of in situ sediment amendment with activated carbon (AC) being carried out in a river will be presented. The pilot-scale demonstration study was conducted in 2006 in Grasse River, NY to study the effectiveness of activated carbon addition to sediment in a field setting. Field sediments in a 0.5-acre plot in the Grasse River were mechanically amended with AC in mixed and unmixed treatment areas. Monitoring before and 1 and 2 years after AC amendment included bioaccumulation tests conducted in situ and ex situ, and the measurements of aqueous equilibrium, PCB desorption kinetics, and the spatial distribution of AC dose achieved in surficial sediments.

Efficiency of the treatment after 1 year depended on dose and method of application and mixing. Treatment sites where the AC was applied, but not mixed into the sediments and received the target dose demonstrated percent reduction in PCB tissue concentrations between 69 and 84% in ex situ measurements. Treatment sites where the activated carbon was mixed into the surficial sediments and achieved the target dose showed 82-92% and 92-95% reductions in average tissue concentrations (as $\mu\text{g/g}$ wet weight) in in situ and ex situ tests, respectively. Bioaccumulation tests 2 years after application showed further reductions from Year 1 levels at nearly all monitoring sites. Based on the 2-year post treatment monitoring data, it appears that PCB bioaccumulation and aqueous concentration decreases with increasing dose of AC up to a dose approximately equal to the native total organic carbon (TOC) content of the sediment. At an AC dose equal to native TOC, reductions in aqueous equilibrium concentration approach 100%, but reduction in PCB concentration in worm tissue and lipid are in the range of 70-95%. A 3-year monitoring was performed in the Fall of 2009 and the samples are being analyzed in the laboratory. Based on the results obtained thus far, it appears feasible to apply AC under 15-feet of water on a large scale in a river. Also, the carbon is preserved in the surficial sediments 2 years after application and it remains effective in reducing contaminant bioavailability.

IN SITU REMEDIATION OF CONTAMINATED SEDIMENTS USING SEQUESTERING AGENTS – EFFECTS ON METAL BIOAVAILABILITY, EROSION, AND ECOTOXICITY

DR. ANNA SOPHIA KNOX
Savannah River National Laboratory
Building 773-92A
Aiken, SC 29808
(803) 725-7021
anna.knox@srnl.doe.gov

CO-PERFORMERS: Dr. Michael H. Paller and Mr. Kenneth L. Dixon (Savannah River National Laboratory); Dr. Jesse Roberts (Sandia National Laboratory)

Current technologies for remediating contaminated sediments include removal followed by treatment and disposal, in situ isolation of the sediments by covering them with a sand or gravel cap (i.e., passive capping), and monitored natural recovery, which involves monitoring natural processes that isolate, degrade, transform, and immobilize contaminated sediments. However, these remedial alternatives offer only temporary solutions, do not address a large variety of contaminants, may not be applicable in both marine and fresh waters, and may harm the benthic environment. In contrast, active capping is a relatively new approach for treating contaminated sediments. It involves applying chemically reactive amendments to the sediment surface. The main role of active caps in regards to contaminants is to stabilize them in sediments, lower their bioavailable pool, and reduce their release into the water column. In addition, downward migration of the amendments used in active caps can neutralize contaminants located deeper in the sediment profile (i.e., in the zone of influence (ZOI)).

Metals are common contaminants in many marine and fresh water environments as a result of industrial and military activities. The mobile, soluble forms of metals are generally considered toxic. They are bioavailable to gill breathing organisms, easily pass through cell walls, and can bioaccumulate in living organisms. Induced chemical precipitation of these metals can shift toxic metals from the aqueous phase to a solid, precipitated phase, which is often less bioavailable. This approach can be achieved through application of sequestering agents such as rock phosphates, organoclays, zeolites, clay minerals, and biopolymers (e.g., chitosan) in active capping technology. Active capping holds great potential for a more permanent solution that avoids residual risks resulting from contaminant migration through or breaching of the cap. In addition to identifying superior active capping agents, research is needed to optimize application techniques and rates and amendment combinations that maximize sequestration of contaminants. A selected set of active capping treatment technologies has been demonstrated at a few sites, including a field demonstration at the Savannah River Site in Aiken, SC. This demonstration has provided useful information on the effects of sequestering agents on metal immobilization, bioavailability, toxicity, and resistance to mechanical disturbance.

REACTIVE MAT CAPPING PERFORMANCE

DR. KEVIN GARDNER
University of New Hampshire
336 Gregg Hall
Durham, NH 03824
(603) 862-4334
kevin.gardner@unh.edu

In situ treatment methods, such as reactive capping technologies, are under intensive research and demonstration for their potential effective use. This presentation will discuss the performance evaluation of thin reactive capping mats impregnated with apatite minerals, capable of sequestering metals, and sorbent materials, capable of sequestering hydrophobic organic contaminants (HOC), for in situ management of contaminated sediments. Reactive mats have been installed in the field in Texas and at two sites in New Hampshire. Performance evaluation has focused on metal and HOC retention by the mats, benthic organism response to mat/cap placement, and feasibility/constructability issues. There have also been a number of sampling adaptations necessary for in situ monitoring that will be discussed.

ASSESSING ECOLOGICAL RECOVERY: SOMETIMES THE QUESTION IS “WHO ISN’T HERE AND WHY?”

JANET THOMPSON
U.S. Geological Survey
345 Middlefield Road
MS 496
Menlo Park, CA 94025
(650) 329-4364
jthomps@usgs.gov

CO-PERFORMER: Sam Luoma (U. S. Geological Survey)

Sediments contaminated with polychlorinated biphenyls (PCB) and polycyclic aromatic hydrocarbons (PAH) pose ecological problems because these contaminants are persistent, bioaccumulative, and toxic. Remediation strategies designed to reduce the effects of these contaminants in sediments face the challenge of assessing the ecological response and success of the remediation action. As part of an in situ remediation of PCBs and PAHs at Hunters Point Naval Shipyard in San Francisco Estuary, we are testing a conceptual model of how in situ contaminant concentrations can be used to predict the ecological characteristics and trajectory of recovery. The ecological basis of our conceptual model is that (1) the benthic species that are present at a location reflect their ability to live, eat, reproduce, and recruit into that location (i.e., the sediment and associated contaminants do not limit the functional requirements of the species), and (2) species that live in contaminated environments do so due to a combination of their specific physiological response to the contaminant and their functional ecology. Tests begin by evaluating several hypotheses that the functional ecology of the benthos at the contaminated site differs from that in similar non-contaminated habitats. For example, we predicted that invertebrates that lay eggs in the sediment and deposit feed in the deep sediment might be challenged by an environment with contaminated sediment (preliminary analysis confirms this hypothesis). Biodynamic models are then used to examine the underlying mechanisms of why some species do better than others in contaminated environments. These models use measures of contaminant uptake, elimination and metabolism, to predict contaminant bio-uptake in individual species, based on in situ contaminant concentrations. Because of the wide range of conditions that are tested in the laboratory, biodynamic models are powerful predictive tools that allow for the prediction of the full range of a species’ contaminant concentrations and their tolerance for the contaminant in the field. The species composition of a recovered site is then predicted based on functional ecology. This prediction is based on an assessment of the available species in the recruitment pool from similar but less contaminated habitats. Assessing species availability and their functional ecology, in combination with the knowledge gained from biodynamic modeling, allows for the forecast of a new post-recovery benthic community.

HUDSON RIVER DREDGING – REVIEW OF YEAR 1 RESULTS

MR. JOHN HAGGARD
General Electric-Corporate Environmental Programs
319 Great Oaks Blvd.
Albany, NY 12203
(518) 862-2730
john.haggard@ge.com

In 2002, the EPA selected dredging to remediate PCBs within the upper Hudson River. Since that time, General Electric (GE) has been working collaboratively with the EPA to implement the project. The project required removal of approximately 2.6 MM cubic yards of sediment. After dredging, backfill or caps are placed depending on the PCB levels remaining. The EPA established unprecedented performance standards for the project including limits on PCB resuspension, PCB air emissions, noise and light levels, achievement of high production rates, and requirements to limit impacts to other river users.

There are two phases of this project. Phase 1 is a season long project designed to remove 265,000 cubic yards (approximately 10% of the project total) of sediments from 88 acres of the river bottom. This phase is a full scale “test” to determine if the project can meet the strict performance standards and will be followed by an independent peer review. After, the EPA will determine if changes to the standards, design, or scope should occur. Phase 2 is the remainder of the project and is currently designed to be completed in five additional dredging seasons.

Phase 1 was implemented from May 15, 2009, to November 15, 2009. An overview of the project approach will be discussed and the results of Phase 1 of the project reviewed.

TECHNICAL SESSION 2B

Topic: *Classification Methods for Military Munitions Response (Part I)*

Chair: Mr. Robert Sadorra, Naval Facilities Engineering Command

Keynote: Mr. Christopher Evans, U.S. Army Corps of Engineers, Baltimore District

Innovative munitions response technologies are making a transition to the field through demonstrations on live munitions response sites. Presentations in this two-part session will focus on recent classification demonstration results at the former Camp San Luis Obispo, California.

| Session 2B - Classification Methods for Military Munitions Response (Part I) | | |
|--|--|--|
| Time | Topic/Title | Speaker Organization |
| 8:30 – 8:40 AM | Welcome & Introduction by the Session Chair | Mr. Robert Sadorra NAVFAC |
| 8:40 – 9:05 AM | KEYNOTE: Challenges at MMRP Sites | Mr. Christopher Evans U.S. Army Corps of Engineers, Baltimore District |
| 9:05 – 9:30 AM | Former Camp San Luis Obispo: Site Description and Data Collection Overview | Dr. Dan Steinhurst Nova Research, Inc. |
| 9:30 – 9:55 AM | EM61 and Magnetic Sensors: Application and Performance Summary at Camp SLO | Dr. Dean Keiswetter SAIC |
| 9:55 – 10:20 AM | BREAK | |
| 10:20 – 10:45 AM | EM61 and Magnetic Sensors: Application and Performance Summary at Camp SLO (continued) | Dr. Dean Keiswetter SAIC |
| 10:45 – 11:35 AM | Processing and Discrimination Strategies for Next-Generation EMI Sensor Data | Dr. Stephen Billings Sky Research, Inc. |
| 11:35 – 11:45 AM | Discussion / Wrap-Up | |

KEYNOTE ADDRESS
CHALLENGES AT MMRP SITES

MR. CHRISTOPHER EVANS
U.S. Army Corps of Engineers, Baltimore District
ATTN: CENAB-EN-HM
P.O. Box 1715
Baltimore, MD 21203
(410) 962-2252
Christopher.L.Evans@usace.army.mil

The keynote address will provide an overview of the Military Munitions Response Program and will identify the challenges that are encountered on these munitions response sites. These challenges include both technical issues and non-technical issues. The address will explain how these different issues are interrelated and how the research being conducted by SERDP and ESTCP are helping to solve both problem areas from a field perspective. Finally, the address will present some real world munitions sites for the consideration of those currently working on classification methods for military munitions response.

FORMER CAMP SAN LUIS OBISPO: SITE DESCRIPTION AND DATA COLLECTION OVERVIEW

DR. DANIEL STEINHURST

Nova Research, Inc.

1900 Elkin Street, Suite 230

Alexandria, VA 22308

(202) 767-3556

dan.steinhurst@nrl.navy.mil

The ESTCP unexploded ordnance (UXO) Classification Study is a multi-year effort to study the implementation of UXO classification technologies and processes in cleanup operations being conducted on real sites under operational conditions in cooperation with regulators and program managers. To build upon the success of the first Study demonstration at the former Camp Sibert, AL (2007), a second demonstration was conducted in 2008–2009 at the former Camp San Luis Obispo (SLO), CA. This was a site with more challenging terrain and topography and a wider mix of targets-of-interest than were seen at former Camp Sibert. Located on the central California coast, the demonstration site was situated to include one former mortar target located on a hillside within the former Camp San Luis Obispo FUDS. Historical records detail a wide variety of munitions usage on the formerly used defense site (FUDS) as a whole with indicated use of 60mm, 81mm, and 4.2-in mortars and 2.36-in rockets within the Study demonstration area.

Data collection was conducted in three phases: (1) site characterization, (2) geophysical data collection, and (3) intrusive investigation/validation. Initial survey results from geophysical sensors were used to define the Study demonstration boundaries and intrusive sampling of small areas was used to support the site use characterization from the historical records. The main portion of the demonstration focused on the collection of high-quality geophysical data with a range of geophysical sensors covering the spectrum from commercially-available to state-of-the-art electromagnetic induction (EMI) sensors currently approaching transition to industry. After geophysical data collection was complete, approximately 2,000 geophysical anomalies were intrusively investigated to provide ground truth as both training data for the data processing demonstrators and as validation data for the Study as a whole.

EM61 AND MAGNETIC SENSORS: APPLICATION AND PERFORMANCE SUMMARY AT FORMER CAMP SAN LUIS OBISPO

DR. DEAN KEISWETTER
SAIC
120 Quade Drive
Cary, NC 27513
(919) 677-1560
keiswetterd@saic.com

In this presentation, the performance of commercial sensors demonstrated at former Camp San Luis Obispo (SLO), California as part of ESTCP's second Large Scale Classification Study will be discussed. Because significant effort was spent during the planning, seeding, and excavation phases, the subject study provides an excellent opportunity to evaluate sensor performance in terms of being able to not only detect the items of interest, but also classify the buried objects as items of interest or not. Multiple targets of interest are present at former Camp San Luis Obispo.

Commercially available electromagnetic induction (EMI) and magnetic sensors have long been used as detection aids during clean-up of sites contaminated with unexploded ordnance. The sensors work by exploiting spatial and temporal changes in the local electromagnetic and/or magnetic fields caused by the presence of the unexploded ordnance (UXO). The degree to which the local electromagnetic and/or magnetic field is altered depends on the composition, size, and shape of the ordnance's metallic casing. Over the years, the commercial EMI and total-field magnetic sensors have proven to be field rugged, easy to use, and capable of detecting isolated ordnance items. In addition to reviewing the basic phenomenology that is exploited by these sensors, the speaker will review the various sensor platforms, the measured data, processing and analysis schemes, available target attributes, and finally, overall performance as demonstrated at former Camp San Luis Obispo. The discussion will provide a performance benchmark using commercial sensors and establish a basis for discussing advanced sensors that are designed to exploit additional details of the targets' EMI response.

PROCESSING AND DISCRIMINATION STRATEGIES FOR NEXT-GENERATION EMI SENSOR DATA

DR. STEPHEN BILLINGS
Sky Research, Inc.
158 Stratton Tce
Manly, QLD 4179 AUSTRALIA
(541) 552-5185
stephen.billings@skyresearch.com

CO-PERFORMERS: Len Pasion, Nicolas Lhomme, Kevin Kingdon, and Fridon Shubitidze (Sky Research); Laurens Beran, Lin-Ping Song, and Doug Oldenburg (UBC-GIF)

Initial attempts at unexploded ordnance (UXO) discrimination used commercially available magnetometers and electromagnetic induction (EMI) sensors that were not specifically designed with a discrimination objective in mind. Systems were typically monostatic (coincident transmitter and receiver), often suffered from temporal drift in the sensor output and required detailed spatial mapping to constrain polarization tensor models of the buried object. Discrimination performance at live sites has been mixed, with some successes but also plenty of failures. Over the past 5 years, SERDP/ESTCP have sponsored the development of a new generation of EMI sensors specifically tailored towards the UXO discrimination problem. These sensors are typically multi-static (multiple transmitters and receivers), highly stable and can be deployed in a static cued-interrogation mode (thus they don't need to be moved during characterization of an anomaly). In this talk, the speaker will give an overview of processing and inversion strategies that have been developed and tailored towards application to these next generation EMI sensors. Specific topics covered will include: (1) General principle of operation and ability to constrain a polarization tensor model of the underlying object; (2) Methods for discrimination using next generation sensors data; (3) Approaches for dealing with multiple-objects in the field of view of the sensor; (4) Ability to constrain more physically complete models of the underlying object; (5) Novel processing approaches to directly constrain the position and depth of buried objects; and (6) Efforts to deploy the next-generation sensors in dynamic one-pass detection and discrimination mode. Methods will be illustrated using results recently obtained during the ESTCP Discrimination Pilot Study at San Luis Obispo (SLO), CA.

TECHNICAL SESSION 2C

Topic: *Environmentally Sustainable Energetics*

Chairs: Dr. Robin Nissan, Naval Air Warfare Center – Weapons Division and Mr. William Ruppert, Hughes Associates, Inc.

Keynote: Mr. Anthony Melita, U.S. Department of Defense – Portfolio Systems Acquisition, Land Warfare and Munitions

To prepare for combat operations, the warfighter must “train as they fight.” This means that real or realistic munitions are required to simulate the stress of combat and to allow the warfighter to understand the capabilities and limitations of their weapons. These munitions use energetic materials with the potential for environmental, safety and occupational health impacts. In order for warfighters to continue to train to standard, environmentally sustainable energetic materials are required for their weapon systems. This session will highlight efforts to address this need, which also encompasses safer insensitive munitions.

| Session 2C - Environmentally Sustainable Energetics | | |
|---|---|---|
| Time | Topic/Title | Speaker Organization |
| 8:30 – 8:40 AM | Welcome & Introduction by the Session Chairs | Dr. Robin Nissan NAWCWD-CL Mr. William Ruppert Hughes Associates |
| 8:40 – 9:05 AM | KEYNOTE: Environmentally Sustainable Energetics - An OSD Perspective | Mr. Anthony Melita U.S. Department of Defense / Portfolio Systems Acquisition, Land Warfare and Munitions |
| 9:05 – 9:30 AM | Formulation of an Environmentally Benign Explosive | Dr. Brian Roos Army Research Laboratory |
| 9:30 – 9:55 AM | Navy IM/Green Energetics with a Focus on Propulsion Systems | Ms. Therese AtienzaMoore Naval Air Warfare Center Weapons Division |
| 9:55 – 10:20 AM | BREAK | |
| 10:20 – 10:45 AM | Insensitive Munitions for Pyrotechnics | Mr. James Wejsa U.S. Army ARDEC |
| 10:45 – 11:10 AM | Status of the Revised National Ambient Air Quality Standards (NAAQS) for Lead | Ms. Kim Teal U.S. EPA Office of Air Quality Planning and Standards |
| 11:10 – 11:35 AM | Development Toward the Removal of Lead from Military Applications | Dr. Sarah Headrick ATK Energetic Systems |
| 11:35 – 11:45 AM | Discussion / Wrap-Up | |

KEYNOTE ADDRESS
ENVIRONMENTALLY SUSTAINABLE ENERGETICS – AN OSD PERSPECTIVE

MR. ANTHONY MELITA
OUSD(AT&L)/PSA/LW&M
3090 Defense Pentagon
Room 5C756
Washington, DC 20301
(703) 695-1382
anthony.melita@osd.mil

In prioritizing and balancing the annual defense budget, Service decisions on how they train and equip our warfighters with the best weapons are of critical importance. While upgrades to electronics and software can occur frequently, upgrades to warheads and rocket motors are infrequent and typically utilize technology of a previous generation. When opportunities to upgrade these components arise, programs need to balance competing requirements—performance, safety, IM, environmental, etc.—when developing and selecting new technologies for integration into a weapon system. An OSD perspective on these issues will be presented.

FORMULATION OF AN ENVIRONMENTALLY BENIGN EXPLOSIVE

DR. BRIAN ROOS
U.S. Army Research Laboratory
Attn: RDRL-WMT-B
Aberdeen Proving Ground, MD 21005
(410) 278-9331
broos@arl.army.mil

The development of new explosive formulations has historically been a difficult balance of trade-offs between performance and sensitivity. Sensitivity was evaluated to enable safe handling, processing and loading, as well as have reliable initiation. Assessments of performance would ensure that the desired outcome could be realized, whether blast, fragmentation, or other specialized effect. With ongoing emphasis towards Insensitive Munitions (IM), the sensitivity aspect has increased to include the response of explosives and munitions to external stimuli including bullet impact, fragment impact, cookoff (fast and slow), sympathetic detonation (or sympathetic reaction), and shaped charge jet impact. Formulations efforts were modified to evaluate IM qualities during early development. Formulations were further refined to be optimized for both performance and IM response. More recently, the environmental impact is being considered early in development. Environmental impact is considered in multiple phases of the life cycle for explosives and munitions that utilize them. Areas for concern include production of the ingredient, production of the formulation, loading of munitions, and the munitions use, specifically in the case of unexploded ordnance and low order detonations. A significant number of munitions utilize ingredients such as RDX and TNT, both of which are toxic and listed as possible human carcinogens. Recent efforts have utilized alternatives to TNT as the melt phase for melt cast explosives for both IM improvement and elimination of the TNT. Other efforts have evaluated RDX replacements as the high explosive used for performance and sensitization. This presentation documents some of the efforts and the developmental process utilized.

NAVY IM/GREEN ENERGETICS WITH A FOCUS ON PROPULSION SYSTEMS

THERESE ATIENZAMOORE
Naval Air Warfare Center Weapons Division
1 Administration Circle (MS1109)
China Lake, CA 93555-6001
(760) 939-7530
therese.atienzamoore@navy.mil

This presentation will provide an overview of propellant technologies being pursued and used in Navy weapons systems, starting with a brief history of some earlier Navy systems and describing the changes these systems have undergone. Changes made since the 70s have largely been made in an effort to improve system and platform survivability, addressing Insensitive Munitions (IM) requirements.

As this pursuit towards low-vulnerability weapons continued, it became apparent that for the propellant materials this vulnerability characteristic had to be balanced with other factors, such as cost, performance, and signature. As development efforts continued it became apparent that the energetic materials alone were going to have a difficult time meeting all of the weapons systems needs. This gave rise to more of a systems approach to meet IM requirements; some examples of these approaches will be provided.

The presentation will go on to address considerations being made to improve sustainability and producibility by reducing environmental impact and addressing emerging environmental regulations. Reviewing some of the recent technology investments that show promise for future solutions along with a discussion of some of the Navy's remaining high-priority propulsion problems will help provide the audience an understanding of additional areas that the Navy is interested in pursuing. Finally, examples of technologies that have the potential of meeting both IM and environmental requirements will be provided.

INSENSITIVE MUNITIONS FOR PYROTECHNICS

MR. JAMES WEJSA
ARDEC
Building 21, Third Street
Picatinny Arsenal, NJ 07806-5000
(973) 724-5441
james.wejsa@us.army.mil

This presentation will discuss pyrotechnic ammunition designs (past and present) relative to insensitive munitions (IM) considerations and their corresponding environmental impacts throughout their life-cycle. This presentation will cover the pyrotechnic insensitive munitions life-cycle considerations and actions taken on pyrotechnic munitions from concepts, R&D, production implementation and sustainment. The speaker will cover IM tools and techniques used; program planning, process flow charts, testing and qualification requirements along with team dynamics for improving the pyrotechnic munition IM posture.

STATUS OF THE REVISED NATIONAL AMBIENT AIR QUALITY STANDARDS (NAAQS) FOR LEAD

MS. KIM TEAL
US EPA Office of Air Quality Planning and Standards
Research Triangle Park, NC 27711
teal.kim@epa.gov

On October 15, 2008, EPA substantially strengthened the national ambient air quality standard (NAAQS) for lead. EPA has revised the level of the primary (health-based) standard from 1.5 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) to $0.15 \mu\text{g}/\text{m}^3$, measured as total suspended particles. EPA has revised the secondary (welfare-based) standard to be identical in all respects to the primary standard. The revised standards are 10 times tighter than the previous primary and secondary standards and will improve health protection for at-risk groups, especially children. These revisions were based on dramatic increases in scientific evidence about lead and its impacts on human health since EPA issued the initial standard of $1.5 \mu\text{g}/\text{m}^3$ in 1978. More than 6,000 new studies on lead health effects, environmental effects and lead in ambient air have been published since 1990. Evidence from health studies shows that adverse effects occur at much lower levels of lead in blood than previously thought. Children are particularly vulnerable to the effects of lead. Exposures to low levels of lead early in life have been linked to effects on IQ, learning, memory, and behavior. There is no known safe level of lead in the body.

In conjunction with strengthening the lead NAAQS, EPA is improving the existing lead monitoring network by requiring monitors to be placed in areas with sources such as industrial facilities that emit one ton or more per year of lead and in urban areas with more than 500,000 people. It is anticipated that some DoD activities related to the production, use, and disposal of energetic materials and munitions that contain lead compounds may be affected by the revised NAAQS.

DEVELOPMENT TOWARD THE REMOVAL OF LEAD FROM MILITARY APPLICATIONS

DR. SARAH HEADRICK
ATK Energetic Systems
Route 114
Radford, VA 24143
(540) 639-8145
sarah.headrick@atk.com

CO-PERFORMERS: Randall Busky (ATK Small Caliber Systems); Joel Sandstrom (ATK Commercial Products); Larry Warren (U.S. Army Aviation & Missile Command); Stephen Stiles (Naval Surface Warfare Center, Indian Head Division)

Removal of lead-based compounds from propellant and ammunition systems has been a primary focus for the defense industry for many years. However, lead-based compounds are presently being used in both cast-cure and extruded double-based propellants. NOSIH-AA-2 propellant, which is employed in the 2.75-inch rocket motor, contains LC-12-15, which is a lead- and copper-based complex. In addition, M36 propellant contains LC-12-6, which is a different lead- and copper-based complex. In both cases, the lead compound serves as a ballistic modifier. Efforts to remove the lead from this propellant have dated back to the early 1990s when possible replacement materials were investigated at the Radford Army Ammunition Plant (RFAAP). This study resulted in the firings of MK90 grains in MK66 motors and it was learned that the candidate formulation met all motor requirements except for action time. Further investigation also revealed that the modifier system did not pass accelerated aging tests. Since then, additional work has been completed at RFAAP, including the recent ESTCP-sponsored project for eliminating lead-based compounds from NOSIH-AA-2. Considerable work toward the elimination of lead in cast-cure propellants has also been completed by the U.S. Army Aviation & Missile Command at the Redstone Arsenal.

In addition to propellant systems, removal of lead from ammunition systems also remains a concern. Lead styphnate is currently used as the main ingredient in most percussion primers despite the development of diazodinitrophenol (DDNP), which has been available as a “green” primer material. Lead styphnate remains the primer of choice due to the poor reliability, hygroscopicity and low flame temperature that is associated with DDNP. Therefore, additional work is being performed in order to provide the industry with improved lead-free percussion primers. One such study being completed at Lake City Army Ammunition Plant (LCAAP) employs a red phosphorus primer formulation. A second study is in progress at ATK Commercial Products centers around the use of nitrocellulose.

This presentation will outline some of the past and present results that have been obtained during the investigation of lead-free propellant and primer formulations along with the lessons learned during the course of these studies.

TECHNICAL SESSION 3A

Topic: *Risk-Based Contaminant Management on Active Training Ranges*

Chairs: Dr. Thomas Jenkins, Thomas Jenkins Environmental Consulting and Ms. Catherine Vogel, Noblis, Inc.

Keynote: Dr. Thomas Jenkins

The long-term sustainability of the Department of Defense's operational ranges is crucial for mission-critical testing and training activities. Such testing and training activities may be endangered if release and migration of munitions constituents from ranges occurs. This session will address recent advances in understanding the fate of energetic materials in the environment and improving sampling and assessment strategies.

| Session 3A - Risk-Based Contaminant Management on Active Training Ranges | | |
|--|---|--|
| Time | Topic/Title | Speaker Organization |
| 1:45 – 1:55 PM | Welcome & Introduction by the Session Chairs | Dr. Thomas Jenkins Thomas Jenkins Environmental Consulting Ms. Catherine Vogel Noblis, Inc. |
| 1:55 – 2:20 PM | KEYNOTE: Residues of Energetic Compounds on DoD Training Ranges | Dr. Thomas Jenkins Thomas Jenkins Environmental Consulting |
| 2:20 – 2:45 PM | Estimating the Surface Loading of Munitions Constituents (MC) on Military Training Ranges | Mr. Alan Hewitt U.S. Army ERDC-CRREL |
| 2:45 – 3:10 PM | Fate of Explosives on Range Soils | Dr. Susan Taylor U.S. Army ERDC-CRREL |
| 3:10 – 3:35 PM | BREAK | |
| 3:35 – 4:00 PM | Soil Properties, Metal Bioavailability and Risk Assessment | Ms. Amy Hawkins NAVFAC-ESC |
| 4:00 – 4:25 PM | Canadian Perspectives on Risk-Based Contaminant Management | Dr. Sonia Thiboutot DRDC Valcartier |
| 4:25 – 4:50 PM | Regulatory Perspectives on Munitions Residues Site Characterization | Mr. Harry Craig U.S. EPA, Region 10 |
| 4:50 – 5:00 PM | Discussion / Wrap-Up | |

KEYNOTE ADDRESS
RESIDUES OF ENERGETIC COMPOUNDS ON DoD TRAINING RANGES

DR. THOMAS JENKINS
Thomas Jenkins Environmental Consulting
43 Gould Road
West Lebanon, NH 03784
(603) 643-2484
tpmsjen@aol.com

In the 1970s and 1980s, the DoD, and the Army in particular, found that many of their ammunition plants and depots were contaminated with residues of high explosives from the synthesis of energetic compounds and the load assemble of packing of military munitions. Analytical methods were developed to enable characterization of source zones, and potentially contaminated ground water. The results indicated that certain energetic chemicals, particularly RDX, were leaching into underlying groundwater at many of these installations, and steps were taken to remove sources of this contamination. In some cases, expensive groundwater treatment systems were also installed when contaminated groundwater was migrating beyond installation boundaries.

Today we are faced with an even more difficult problem, the potential risk associated with residues of these same chemicals on DoD training ranges. Due to a substantial investment in research by SERDP/ESTCP and the Canadian DND, the types of residues present at various types of ranges are now understood. Experiments have revealed the extreme heterogeneity in the distribution of residues at these ranges, complicating the characterization of source zones. Due to SERDP sponsorship, sampling methods have been developed to allow the collection of representative soil samples in these environments, and laboratory methods have been modified to allow accurate and precise results for these samples. Except for a few Canadian training ranges, the Massachusetts Military Reservation and Fort Lewis, the degree of groundwater contamination with these energetic residues in groundwater at ranges is largely unknown. The physical size of these ranges makes the task daunting, but it also makes the consequences of ignoring the problem in the present a huge potential expense to the DoD in the future.

ESTIMATING THE SURFACE LOADING OF MUNITIONS CONSTITUENTS (MEC) ON MILITARY TRAINING RANGES

MR. ALAN HEWITT
U.S. Army ERDC-CRREL
72 Lyme Road
Hanover, NH 03755-1290
(603) 646-4388
Alan.D.Hewitt@usace.army.mil

CO-PERFORMERS: Marianne E. Walsh, Michael R. Walsh, and Susan R. Bigl (U.S. Army ERDC-CRREL); Thomas Georgian (USACE Environmental and Munitions Center of Expertise); Mark A. Chappell (U.S. Army ERDC-EL); Charles A. Ramsey (EnviroStat, Inc.)

Today, an expanding body of guidance is available for site characterization activities addressing the concentration and mass of energetic and metallic residues in military training range soils. Documentation of this information can be found on the web sites of the U.S. Environmental Protection Agency, DoD Environmental Data Quality Workgroup, and the U.S. Army Corps of Engineers Environmental and Munitions Center of Expertise. As a consequence, characterization of these potentially hazardous constituents can be addressed within a consistent framework.

The ultimate goal of site characterization is to establish representative mean soil concentrations to allow for the estimation of mass loading. To address the compositional and distributional heterogeneity associated with MC particulates, the sampling strategy must strive to acquire samples that contain the constituents of concern in the same proportion as the bulk matrix present within the decision unit (sampled area, population, exposure unit). This objective can be frequently achieved for soil with 1 kg or larger samples built by combining 50 or more increments collected using a systematic-random sampling design throughout the area of concern. Moreover, to ensure that the subsample taken for analysis of MC is representative of the sample, the sample must be thoroughly ground.

Adoption of these recognized protocols will address the compositional and distributional heterogeneity of MC over military training ranges and provide military programs with a reliable means of ranking the mass loading within areas where deposition is likely. Research has shown that, in general, MC are deposited on the surface, and the highest concentrations exist at firing positions, near targets, and where demolition activities are performed. In the case of energetic residues, the greatest source is from rounds that fail to detonate as designed. For metallic residues, highest concentrations are typically found in earthen backstops where bullets accumulate as a consequence of small arms training activities. Managing the locations where MC are deposited will help sustain training range availability and help to prevent off-site migration.

FATE OF EXPLOSIVES ON RANGE SOILS

DR. SUSAN TAYLOR
U.S. Army, ERDC-CRREL
72 Lyme Road
Hanover, NH 03755-1290
(603) 646-4239
Susan.Taylor@usace.army.mil

CO-PERFORMERS: Dr. James H. Lever, Jennifer Fadden, Nancy Perron, and Susan Bigl (CRREL); Dr. Bonnie Packer (AEC)

Military ranges provide soldiers the opportunity to train using a variety of munitions. However, live fire training can result in unexploded ordnance and low-order detonations. The latter deposit readily dissolvable cm- and mm-sized pieces of high explosive (HE). Commonly used explosives are toxic and, consequently, have low drinking water screening levels. Although explosive pieces may not represent a training hazard, scattered gram-to-kilogram quantities may present a significant risk to groundwater.

Range characterization studies have mapped the distribution of HE residues and estimated their mass in soils. Researchers have measured the partitioning coefficients between aqueous explosive solutions and different types of soils to estimate retardation factors and biodegradation effects. Existing 1-D and 2-D models predict flow through porous media and can be used to estimate the transit times of HE-laden precipitation to groundwater. To make a first-order estimate of aqueous influx of HE to groundwater, however, we were missing the dissolution rate as a function of particle size and HE particle size distributions on ranges.

We measured dissolution by exposing chunks of TNT, Tritonal, Comp B and C4 to outdoor conditions and analyzed the resulting effluent. These data and concurrently collected weather data constitute a three-year record that we used to validate our drop-impingement dissolution model. Starting particle size, HE type, annual rainfall and average temperature are the model inputs. Because dissolution occurs at a particle's surface we also investigated processes such as cracking, spalling and splitting that increase HE influx and photo-transformation of the HE into other compounds that decrease HE influx.

Although the drop-impingement model offers a simple and accurate method to predict aqueous-phase HE influx, the starting population of the HE particles on the range is unknown. Earlier work showed that low-order detonations produced particle sizes that follow a power-law distribution, and HE chunks crushed as part of this work produced daughter particles that follow power-law distributions. Thus, we may be able to make crude estimates for particle numbers and sizes given estimates of total HE mass obtained from soil sampling or wide-area assessments. Uncertainties of HE mass reaching groundwater will be high, but estimates may still prove useful to range managers to guide future training and cleanup activities.

SOIL PROPERTIES, METAL BIOAVAILABILITY AND RISK ASSESSMENT

MS. AMY HAWKINS
Naval Facilities Engineering Service Center
1100 23rd Avenue
Port Hueneme, CA 93043
(805) 982-4890
amy.hawkins@navy.mil

CO-PERFORMERS: Dr. Nick Basta and Dr. Roman Lanno (The Ohio State University);
Dr. Mark Barnett (Auburn University); Dr. Phil Jardine (Oak Ridge National Lab);
Dr. Stan Casteel (University of Missouri); Dr. Kaye Savage (Wofford College)

Heavy metals are often contaminants of potential concern at ranges and other contaminated sites. As the DoD assesses risks related to metals, the question of whether or not to adjust relative bioavailability from screening level assumptions of 100% may arise. ESTCP project ER-0517 addresses the practicality of these types of adjustments by making a broad range of comparisons for twelve different DoD soils contaminated with Pb, Cd, Cr and/or As.

Initial observations for each soil require physical and chemical characterization data, including general soil properties and analysis by synchrotron X-ray techniques. This is followed by a comparison of risk assessment approaches.

Human health risk assessment is first undertaken using standard risk assessment screening levels assuming 100% relative bioavailability. Juvenile swine studies were done as part of the project and the relative bioavailability results can be compared to the screening risk results. Finally, multiple in vitro techniques were completed on these same soils. Comparison is made of the in vitro results to the other approaches.

A similar approach is taken for ecological risk assessment. Screening is done using EPA's Eco-SSLs which assume high bioavailability. These results will be compared to bioavailability and risk results using in vivo plant and earthworm studies with the study soils and also looking at the predictive abilities of soil models and extractions.

Finally, regulatory acceptance and practical applicability of the various techniques for range and other site assessments is discussed.

CANADIAN PERSPECTIVES ON RISK-BASED CONTAMINANT MANAGEMENT

DR. SONIA THIBOUTOT
DRDC Valcartier
2459 Pie XI Blvd. North
Québec, QC G3J 1X5 CANADA
(418) 844-4000, Ext. 428
sonia.thiboutot@drdc-rddc.gc.ca

CO-PERFORMERS: Dr. Guy Ampleman, Dr. Sylvie Brochu, Dr. Emmanuela Diaz, and Dr. Isabelle Poulin (DRDC Valcartier); Dr. Thomas Jenkins, Mr. Michael Walsh, Ms. Marianne Walsh, Dr. Suzan Taylor, and Mr. Alan Hewitt (CRREL); Dr. Richard Martel (INRS-ETE); Dr. Jalal Hawari, Dr. Geoffrey Sunahara, Dr. Pierre Yves Robidoux, Dr. Fanny Monteil-Rivera, Dr. Bernard Lachance, and Ms. Sylvie Rocheleau (Biotechnology Research Institute/NRC); Dr. Roman G. Kuperman, Dr. Ronald T. Checkai, and Dr. Michael Simini (U.S. Army Edgewood Chemical Biological Center); Major Robert Lajoie and Ms. Karine Legault (Director Land Environment)

In the past 18 years, Canada has developed a cutting-edge, worldwide expertise in the characterization of Ranges and Training Areas (RTAs) and the study of the environmental fate of energetic materials in close collaboration with ERDC scientists. Major environmental issues have been identified and the sources of munitions constituents in training ranges are better understood. Protocols have been developed for collecting representative samples and samples processing have been carefully studied and optimized. In the last years, a large effort was dedicated to the measurement of the deposition rate of munitions constituents both at the target impacts area and at the firing positions, which leads to a good estimation of the source terms of contaminants generated by various live firing activities. In Canadian Army RTAs, efforts were dedicated to both the surface and the subsurface, and detailed hydrogeological and geological characterization were conducted. This led to the acquisition of a large database and a better understanding of the complex dispersion and fate of munitions-related contaminants. All the data acquired over the last years have been used to build maps of hazards and vulnerability, which can then be combined to draw risk maps that will represent great assets from a risk-management perspective. In parallel to that, the study of the ecotoxicological impacts of munitions constituents led to the development of preliminary environmental threshold values and benchmark toxicity data for nitrogen-based energetic materials. The next step will be the development of environmentally sound solutions that will sustain military training and maintain force readiness by minimizing the impacts of military operations on the environment. To achieve this, Canada initiated a Technical Demonstration Project (TDP) in 2008 to develop greener and insensitive munitions (IM) that will ease the environmental pressure on RTAs and minimize the health hazards to the users without decreasing the performances. Efforts are also dedicated to the modification of actual live firing activities to minimize environmental adverse impacts and remediation of sites where levels of concerns of munitions-related contaminants have been identified will be undertaken.

REGULATORY PERSPECTIVES ON MUNITIONS RESIDUES SITE CHARACTERIZATION

HARRY D. CRAIG
U.S. EPA Region 10
Oregon Operations Office
805 SW Broadway, Suite 500
Portland, OR 97205
(503) 326-3689
craig.harry@epa.gov

Reliable site characterization is a fundamental step in providing representative data to assess the degree of residual contamination from past training activities at ranges and from open burn/open detonation (OB/OD) disposal operations. Characterization data is used to conduct risk assessments of chemical contamination hazards at these sites. This presentation will provide an overview of regulatory issues related to: (1) sources and patterns of environmental contamination, (2) toxicity of munitions compounds, (3) uncertainties in environmental fate and transport properties, and (4) good practices and remaining challenges in use of sampling design and fate and transport models to assess the nature of potential contamination at munitions sites.

TECHNICAL SESSION 3B

Topic: *Classification Methods for Military Munitions Response (Part II)*

Chair: Mr. Guy Warren, Alaska Department of Environmental Management

Keynote: Ms. Stephanie Cappa, U.S. House of Representatives – Office of the Honorable Earl Blumenauer

Innovative munitions response technologies are making a transition to the field through demonstrations on live munitions response sites. Presentations in this two-part session will focus on recent classification demonstration results at the former Camp San Luis Obispo, California.

| Session 3B - Classification Methods for Military Munitions Response (Part II) | | |
|---|--|---|
| Time | Topic/Title | Speaker Organization |
| 1:45 – 1:55 PM | Welcome & Introduction by the Session Chair | Mr. Guy Warren Alaska Department of Environmental Management |
| 1:55 – 2:20 PM | KEYNOTE: Unexploded Ordnance: A View from Capitol Hill | Ms. Stephanie Cappa U.S. House of Representatives/Office of the Honorable Earl Blumenauer |
| 2:20 – 2:45 PM | BUD Cued Survey Results from San Luis Obispo, CA | Dr. Erika Gasperikova Lawrence Berkeley National Laboratory |
| 2:45 – 3:10 PM | Classification Performance with an Array of TEM Sensors at San Luis Obispo | Dr. Thomas Bell SAIC |
| 3:10 – 3:35 PM | BREAK | |
| 3:35 – 4:00 PM | UXO Classification with Static-Mode MetalMapper™ Data from SLO | Dr. Skip Snyder Snyder Geosciences |
| 4:00 – 4:25 PM | Active Supervised and Semi-Supervised Learning at SLO | Professor Larry Carin Signal Innovations Group |
| 4:25 – 4:50 PM | ESTCP Live Site Demonstration Program | Dr. Herb Nelson SERDP/ESTCP |
| 4:50 – 5:00 PM | Discussion / Wrap-Up | |

BUD CUED SURVEY RESULTS FROM SAN LUIS OBISPO, CA

DR. ERIKA GASPERIKOVA
Lawrence Berkeley National Laboratory
One Cyclotron Road
MS:90R1116
Berkeley, CA 94720
(510) 486-4930
egasperikova@lbl.gov

CO-PERFORMERS: J. T. Smith; K. Kappler; H. F. Morrison; A. Becker

The Berkeley UXO Discriminator (BUD) is an optimally designed active electromagnetic (EM) system that not only detects but also characterizes unexploded ordnance (UXO). The system incorporates three orthogonal transmitters and eight pairs of differenced receivers. BUD is mounted on a small cart to assure system mobility. System positioning is provided by state-of-the-art real-time kinematic (RTK) global positioning system (GPS) receiver. The system operates either in a search mode, in which the system moves along a profile and exclusively detects targets in its vicinity providing target depth and horizontal location or in a discrimination mode, in which the system, stationary above a target, from a single position, determines three discriminating polarizability responses together with the object location and orientation. Field survey results from various test sites clearly show that BUD can resolve the intrinsic polarizabilities of a target, and that there are very clear distinctions between symmetric intact UXO and irregular scrap metal or clutter. Nearly intact UXO displays a single major polarizability coincident with the long axis of the object and two equal, smaller transverse polarizabilities, whereas metal scraps have distinct polarizability signatures that rarely mimic those of elongated symmetric bodies.

After a very successful discrimination survey at the former Camp Sibert in Alabama, with one target-of-interest (TOI) and a benign topography, we participated in a discrimination survey at the former Camp San Luis Obispo (SLO) with a challenging terrain, a wider mix of TOIs, and multiple objects present. We will present results of our discrimination approach in these challenging field conditions and when multiple objects are present.

This research was funded by SERDP/ESTCP under projects MM-1225, MM-0437, and MM-0838.

CLASSIFICATION PERFORMANCE WITH AN ARRAY OF TEM SENSORS AT SAN LUIS OBISPO

DR. THOMAS BELL
Science Applications International Corporation
1225 S. Clark Street, Suite 800
Arlington, VA 22202
(703) 414-3904
bellth@saic.com

CO-PERFORMERS: Dr. James Kingdon (SAIC); Dr. Daniel Steinhurst and Mr. Glenn Harbaugh (Nova Research); Mr. David George (G&G Sciences)

A twenty-five element planar array of transient electromagnetic induction (TEM) sensors developed by the Naval Research Laboratory (NRL) under SERDP and ESTCP sponsorship was deployed to the former Camp San Luis Obispo (SLO) as part of the large scale ESTCP Classification Study. The TEM array, which is towed behind a modified dune buggy, is used in a cued interrogation mode. It is delivered by the tow vehicle to a series of global positioning system (GPS)-flagged locations corresponding to anomalies detected during prior digital geophysical mapping (DGM) of the site. The array is stopped and data are collected for about 1½ minutes at each target location. Several hundred anomalies per day can be interrogated in this way at a site like the former Camp SLO. The array data are inverted to determine the principal axis eddy current decay functions of the targets. Classification is based on comparing the eddy current decay functions for each target with those of the various munitions targets of interest at the site, as well as a variety of clutter items that are representative of the non-hazardous metal debris at the site. We report the classification performance results with the TEM array for roughly 1,300 unknown targets at the former Camp SLO, and compare the classification performance with the results from earlier testing of the system at the Aberdeen Proving Ground Standardized UXO Demonstration Site.

UXO CLASSIFICATION WITH STATIC-MODE METALMAPPER[™] DATA FROM SLO

DR. D.D. "SKIP" SNYDER
Snyder Geoscience, Inc.
671 Crescent Court
Grand Junction, CO 81505
(970) 254-0330
skips@bresnan.net

CO-PERFORMERS: David C. George (G&G Sciences, Inc); Dr. Mark Prouty (Geometrics, Inc);
Dr. Tom King (Zapata/Blackhawk); Dr. Mary Poulton (University of Arizona); Anna
Szidarovszky (Zonge Engineering)

The MetalMapper[™] is one of several advanced EMI systems currently being demonstrated with support from ESTCP (ESTCP Project MM-0603). Characterized by complex antenna geometries that include multiple transmitter and receiver antennas, the principal advantage of these systems lies in their ability to acquire sufficient data at a single location (station) for classification with physics-based models.

Geometrics, Inc (San Jose, CA) has undertaken the MetalMapper project with the objective of commercializing this technology. In 2008, the MetalMapper successfully completed a demonstration at the Standardized UXO Technology Demonstration Site at Aberdeen Proving Ground (APG). This year, the MetalMapper participated in the ESTCP Program Office's Classification Study at the Former Camp San Luis Obispo (SLO) in California. At SLO, the MetalMapper acquired single-station data over approximately 2,000 targets after first surveying the 12-acre test area in dynamic acquisition mode to detect those targets. This presentation will present results of our analysis to classify the targets. The presentation highlights some of the problems and pitfalls that were encountered in our efforts not only to discriminate between ordnance and clutter but also to identify four different munitions of interest. Our results were scored by the Institute for Defense Analyses (IDA) and those scores will be presented.

ACTIVE SUPERVISED AND SEMI-SUPERVISED LEARNING AT SLO

PROFESSOR LAWRENCE CARIN

Signal Innovations Group
1009 Slater Road, Suite 200
Durham, NC 27703
(919) 475-2151
lcarin@siginnovations.com

CO-PERFORMERS: Levi Kennedy, Nilanjan Dasgupta, and Xianyang Zhu (SIG)

An active learning technology avoids the need for a priori labeled data matched to the site under test. Information-theoretic metrics are employed to define which items would be most informative to design of a classifier, if the associated labels could be acquired. The associated items are then excavated for the purpose of learning, initially not concerned with whether they are associated with a unexploded ordnance (UXO) or clutter. The labels so acquired are then employed to design a classifier, which is then employed to define which items may be left unexcavated. We consider this technology for sensor data collected at San Louis Obispo (SLO), based on supervised and semi-supervised classifiers.

ESTCP LIVE SITE DEMONSTRATION PROGRAM

DR. HERB NELSON
SERDP/ESTCP
901 N. Stuart Street, Suite 303
Arlington, VA 22203
(703) 696-8726
herbert.nelson@osd.mil

ESTCP has sponsored two live site demonstrations of classification methods applied to munitions response sites. The first of these, at former Camp Sibert, AL, was discussed at a previous Symposium. This presentation will summarize the results from the second demonstration at former Camp San Luis Obispo (SLO), CA, which was a much more challenging site. The performance of both commercially available sensors and advanced sensors emerging from the research program will be discussed. The presentation will conclude by outlining our plans for additional demonstrations in the coming years.

TECHNICAL SESSION 3C

Topic: *DoD Greenhouse Gas Emissions: Land Use and the Installation Carbon Footprint*

Chairs: Ms. Maureen Sullivan and Mr. William Van Houten, U.S. Department of Defense – Environmental Management Directorate

Keynote: Dr. Richard Birdsey, U.S. Department of Agriculture – Forest Service, Northern Research Station

Without a complete understanding of an installation’s carbon footprint, it will not be possible to target the most cost-effective and environmentally friendly mitigation strategies. Various protocols are now available to assist an installation in estimating its direct emissions, those emissions that arise indirectly through its purchase of energy, and those emissions that arise from its purchase of products, travel, and other indirect sources. What is largely missing is an understanding of how land use and management on the installation can either contribute to greenhouse gas emissions or act as a mitigation mechanism through appropriate management of the carbon cycle commensurate with other land management goals. This session will focus on the role of land use in an overall strategy for understanding and managing an installation’s carbon footprint, how appropriate management may differ by ecosystem, and important data, tool development, and science gaps.

| Session 3C - DoD Greenhouse Gas Emissions: Land Use and the Installation Carbon Footprint | | |
|---|---|---|
| Time | Topic/Title | Speaker Organization |
| 1:45 – 1:55 PM | Welcome & Introduction by the Session Chairs | Ms. Maureen Sullivan and Mr. William Van Houten OUSD(I&E) |
| 1:55 – 2:20 PM | KEYNOTE: The Potential Role of U.S. Military Lands in Reducing Carbon Dioxide Emissions and Increasing Carbon Sequestration | Dr. Richard Birdsey USDA-FS / Northern Research Station |
| 2:20 – 2:45 PM | Emerging Federal Framework for Greenhouse Gas Accounting | Mr. Matthew Gray U.S. Department of Energy |
| 2:45 – 3:10 PM | Estimating Carbon Sequestration on Military Lands: Methods and Case Studies | Dr. Coeli Hoover USDA-FS / Northern Research Station |
| 3:10 – 3:35 PM | BREAK | |
| 3:35 – 4:00 PM | Carbon Offset Accounting | Mr. Neil Sampson The Sampson Group, Inc. |
| 4:00 – 4:25 PM | The National Assessment of Current and Potential Greenhouse Gas Sequestration | Dr. Beatrice Van Horne U.S. Geological Survey |
| 4:25 – 4:50 PM | Panel Discussion | |
| 4:50 – 5:00 PM | Discussion / Wrap-Up | |

KEYNOTE ADDRESS

**THE POTENTIAL ROLE OF U.S. MILITARY LANDS IN REDUCING CARBON
DIOXIDE EMISSIONS AND INCREASING CARBON SEQUESTRATION**

DR. RICHARD A. BIRDSEY
USDA Forest Service
11 Campus Boulevard, Suite 200
Newton Square, PA 19073
(610) 557-4091
rbirdsey@fs.fed.us

Global policies to manage greenhouse gases are evolving with strong consideration of the role of land management. The U.S. land base currently emits about 7% of total U.S. greenhouse emissions, mainly from crop and livestock production, but also offsets about 12% of greenhouse emissions, mainly from regrowing forests and sequestration in wood products. Federal lands, which constitute 30 percent of the U.S. land base, are a significant part of the estimated land offset for fossil fuels and may have a unique role to play in domestic greenhouse gas mitigation programs. Military lands cover almost 30 million acres in the U.S. and span a wide range of ecosystems with a corresponding diversity of biological potential for additional carbon sequestration, from very low for desert ecosystems to some of the highest potential on productive forest sites across the country. Prospects for realizing this potential are complicated by the unique mix of land management objectives for Department of Defense installations.

EMERGING FEDERAL FRAMEWORK FOR GREENHOUSE GAS ACCOUNTING

MR. MATTHEW GRAY
U.S. Department of Energy
1000 Independence Avenue, SW
Post Code: EE-2L
Washington, DC 20585
(202) 586-0067
matthew.gray@ee.doe.gov

Climate change is an unprecedented challenge that requires immediate action to protect the health of people, plants, and animals alike. The Federal Government can lead by example in mitigating climate change and enhancing the nation's energy security. This session highlights current and upcoming initiatives to help in doing just that, focusing on greenhouse gas guidance development and technical assistance.

The U.S. Department of Energy's (DOE) Federal Energy Management Program (FEMP) supports Federal agencies in calculating, managing and reducing their greenhouse gas emissions. The program supports FEMP's mission to facilitate the Federal Government's implementation of sound, cost-effective energy management and investment practices to enhance the nation's energy security and environmental stewardship.

President Barack Obama signed E.O. 13514, Federal Leadership in Environmental, Energy, and Economic Performance, on October 5, 2009. The order represents a transformative shift in the way the government operates by:

- Establishing GHGs as the integrating metric for tracking progress in Federal sustainability;
- Requiring a deliberative planning process; and
- Linking to budget allocations and OMB scorecards to ensure goal achievement.

Under Section 9 of EO 13514, FEMP has been specifically tasked to develop procedures that will enable federal agencies to consistently quantify their scope one, two and three emissions. The guidance will also account for sequestration and emissions from land management practices.

FEMP offers greenhouse gas management and abatement services to help Federal agencies meet the goals and requirements of E.O. 13514 and other laws and regulations. These services include technical assistance to help Federal agencies:

- Compile greenhouse gas emission inventories through data collection, calculation, and emissions reporting
- Analyze greenhouse gas emission inventories to establish reduction targets, develop reduction plans, and identify high-impact areas for reductions
- Develop and facilitate training workshops and Internet-based courses that provide access to greenhouse gas management and abatement best practices
- Raise awareness through FEMP outreach efforts, including the FEMP Web site, mailing lists, and greenhouse gas related awareness campaigns

ESTIMATING CARBON SEQUESTRATION ON MILITARY LANDS: METHODS AND CASE STUDIES

COELI HOOVER
U.S. Forest Service, Northern Research Station
271 Mast Road
Durham, NH 03824
(603) 868-7633
choover@fs.fed.us

As the concentration of carbon dioxide in the atmosphere continues to rise, ways to mitigate the increase are receiving more attention. One possible option is to temporarily sequester more carbon in forests; U.S. forests currently offset about 10% of national greenhouse gas emissions. Sequestering more carbon in forests can be achieved in several ways—by afforesting lands not currently in forest cover, by reforestation of lands, and through improved forest management. Typically, gains through improved management can be small on a per acre basis. Military installations with large amounts of forested acres may provide an opportunity for increased forest carbon sequestration.

What kind of data and tools are needed to develop forest carbon estimates? What carbon pools should be measured? How do you compare carbon sequestration rates in different forest types or different management treatments? This paper will describe the principles of carbon accounting, show common methods used to develop carbon stock estimates, and provide examples from several military installations.

CARBON OFFSET ACCOUNTING

MR. NEIL SAMPSON
The Sampson Group, Inc.
5209 York Road
Alexandria, VA 22310
(703) 924-0773
neil@visionforestry.com

While it is a fairly straightforward scientific exercise to account for carbon in soils and trees and to estimate carbon stock changes over time by taking a series of measurements, the accounting for sequestered carbon as a legitimate offset for greenhouse gas emissions is a policy-driven process that still contains many unknowns. In the United States, the policies surrounding agriculture and forest offsets have been emerging in state, regional, and private programs, and there are some indications that a national policy could emerge in the near future. How those policies ultimately treat specific details such as project eligibility, baseline setting, calculations of additionality, requirements for permanence, and discounts for leakage will determine whether or not carbon sequestration projects can become a feasible option for land managers. The policies being discussed in Congress today seem to open the door for land-based carbon offset projects, but many of the specific details that will be critical in the future of these projects will be established in program rule-making. That suggests that, even at top speed, the detailed questions around carbon sequestration projects in agriculture and forestry will not be answered for two years or more. In the meantime, efforts to develop scientific and institutional experience in carbon project accounting will continue, and possibly accelerate if Congressional policy establishes that early action efforts are to be included in the final program rules.

THE NATIONAL ASSESSMENT OF CURRENT AND POTENTIAL GREENHOUSE GAS SEQUESTRATION

DR. BEATRICE VAN HORNE
U.S. Geological Survey
12201 Sunrise Valley Drive
Reston, VA 20192
(703) 648-4053
bvanhorne@usgs.gov

Land and natural resource management to protect carbon stocks and sequester additional carbon must take a number of factors into account. These include the effects of management activities on other management priorities, roles and risks of disturbance events such as fire or extreme weather events and the related permanence of carbon storage, and the overall value of proposed management in forestalling global warming. Management efforts have understandably focused on forested and agricultural systems, although management in other types of ecosystems may be important. The additive effects of project management should be understood in the context of broad-scale natural and human-induced fluxes of greenhouse gases. As mandated by the Energy Independence and Security Act of 2007, the U.S. Geological Survey is working with other agencies to develop the methodology for assessing greenhouse gas stocks and fluxes by ecosystem type at a national scale. This assessment will provide scientifically sound information about effectiveness and risk in a national to regional context so managers can better evaluate costs and benefits of proposed projects for managing greenhouse gas stocks and fluxes.

TECHNICAL SESSION 3D

Topic: *Aircraft Emissions: Future Impacts and Alternative Fuels*

Chairs: Dr. Mel Roquemore, Air Force Research Laboratory and Dr. Richard Miake-Lye, Aerodyne Research, Inc.

Keynote: Dr. Ian Waitz, Massachusetts Institute of Technology – Department of Aeronautics and Astronautics

Increasing costs of aviation fuel and the growing dependence on foreign sources of petroleum are driving the development of high fuel efficient gas turbine engines and alternative fuels. High engine operating pressures and temperatures are critical for high fuel efficiencies but are conducive to the formation of nitrogen oxides (NO_x) and particulates (PM_{2.5}). Alternative fuels can affect aircraft emissions but not always in predictable ways, especially at high pressures. Modeling and measurements of emissions of NO_x, hydrocarbons, and particulate emissions are advancing rapidly, in parallel with the understanding of how these emissions, in concert with the primary emission of carbon dioxide, affect air quality and the global atmosphere. This session will provide an overview of future impacts of gas turbine engine technology and alternative fuels on aircraft emissions.

| Session 3D - Aircraft Emissions: Future Impacts and Alternative Fuels | | |
|---|---|---|
| Time | Topic/Title | Speaker Organization |
| 1:45 – 1:55 PM | Welcome & Introduction by the Session Chairs | Dr. Mel Roquemore Air Force Research Laboratory Dr. Rick Miake-Lye Aerodyne Research, Inc. |
| 1:55 – 2:20 PM | KEYNOTE: Environmental Impacts of Aircraft | Professor Ian Waitz Massachusetts Institute of Technology / Department of Aeronautics and Astronautics |
| 2:20 – 2:45 PM | Air Force Vision of Alternative Fuels and Fuel Efficient Engines | Mr. Robert Hancock Air Force Research Laboratory |
| 2:45 – 3:10 PM | Gas Turbine Engine Emissions Challenges with Alternative Fuels | Dr. Hukam Mongia Purdue University / School of Mechanical Engineering |
| 3:10 – 3:35 PM | BREAK | |
| 3:35 – 4:00 PM | Models for Predicting Soot Particulate Emissions from Combustors: Evolution, Status and Needs | Dr. Med Colket United Technologies Research Center |
| 4:00 – 4:25 PM | Emissions from JP8 and Alternative Fuels | Mr. Edwin Corporan Air Force Research Laboratory |
| 4:25 – 4:50 PM | Evolution of Aircraft Engine Emissions in the Atmosphere | Dr. Scott Herndon Aerodyne Research, Inc. |
| 4:50 – 5:00 PM | Discussion / Wrap-Up | |

KEYNOTE ADDRESS
ENVIRONMENTAL IMPACTS OF AIRCRAFT

PROFESSOR IAN A. WAITZ
MIT Department of Aeronautics and Astronautics
33-207, MIT
77 Massachusetts Avenue
Cambridge, MA 02139
(617) 253-0218
iaw@mit.edu

The environmental impacts of aviation—climate change, surface air quality and community noise—involve a variety of physical effects that occur over a range of length-scales and time-scales. The impacts result from complex relationships among physical phenomena, technology, operations, policies, and personal behavior. The talk will provide an overview of some of the important relationships. Quantitative estimates of the magnitude of the environmental impacts of aviation will be presented, and key scientific and policy uncertainties will be identified. A particular focus will be provided on recent research regarding the climate and air quality impacts of aircraft emissions with an eye toward evaluating opportunities for mitigating these impacts through technology, operations and alternative fuels.

AIR FORCE VISION OF ALTERNATIVE FUELS AND FUEL EFFICIENT ENGINES

DR. ROBERT HANCOCK
Air Force Research Laboratory
1950 Fifth Street
AFRL/RZTC
WPAFB, OH 45433-7251
(937) 255-6814
robert.hancock@wpafb.af.mil

The United States Air Force mission requires the use of efficient turbine engines and jet fuels that are both available and affordable. The development of highly efficient, low-polluting turbine engines is an important area of emphasis within the Air Force. The Adaptive Versatile Engine Technology (ADVENT) program and Highly Efficient Embedded Turbine Engine (HEETE) program are both focused on developing and demonstrating the next generation of highly capable, fuel-efficient low-emissions turbine engines. These engines operate at temperatures and pressures that challenge conventional control of gaseous and particulate emissions. In a parallel effort, the Air Force is interested in the development of alternative fuels as a source of available and potentially affordable fuel. As alternative fuels become available, their properties and combustion characteristics must be evaluated and each fuel must be certified for use in military aircraft. The certification of an alternative fuel is a time consuming and expensive process that is complicated by the need to certify each promising alternative fuel. The Air Force is teaming with engine manufacturers, fuel suppliers, small businesses, and universities to: (1) evaluate the combustion characteristics of alternative fuels, (2) establish common qualification tests, (3) develop predictive fuel behavior and combustion models, and (4) chart a path forward for certifying promising alternative fuels for use in military aircraft. The combination of more efficient turbine engines and additional available and affordable jet fuels is helping the United States Air Force become more energy-flexible and capable of meeting its important mission.

GAS TURBINE ENGINE EMISSIONS CHALLENGES WITH ALTERNATIVE FUELS

HUKAM MONGIA
Purdue University
500 Allison Road
West Lafayette, IN 47907
(765) 494-5640
hmongia@purdue.edu

CO-PERFORMERS: K. Inn; G. Mitchum; S. Naik; R. Lucht

High-performance energy efficient military turbo-propulsion engines for JP-8 fuel have continued to evolve over the years with some guidance provided by combustion models and CFD. However, several combustion technological challenges need to be addressed for burning alternative fuels, including Fischer–Tropsch and/or hydrotreated renewable jet fuels, without adversely impacting performance, durability and operability. This process of making military engines more fuel flexible will be greatly expedited with the advent of a new generation of combustion models and computational effort relevant to the combustion technologists. After giving an overview of the three emissions papers by Mongia planned for the 2010 Aerospace Sciences meeting (AIAA Papers 2010-1329, 1529 and 1530), this presentation will elaborate on the recent fundamental experimental and modeling effort of the group on idealized opposed flame in gas turbine relevant conditions.

MODELS FOR PREDICTING SOOT PARTICULATE EMISSIONS FROM COMBUSTORS: EVOLUTION, STATUS AND NEEDS

MED COLKET
United Technologies Research Center
411 Silver Lane
East Hartford, CT 06108
(860) 610-7481
colketmb@utrc.utc.com

The detailed physical and chemical processes controlling soot formation and oxidation leading to particulate emissions from an engine have been under investigation for over 45 years. Early studies were driven by diagnostics in which the emissions were altered by the sampling process and models that were hampered by the lack of chemical processes controlling soot inception and growth. Without empirical methods, attempts to model soot production in simple fundamental experiments resulted in agreements of soot mass that were many factors (>1000) in error, although some trends were captured. With increased understanding and better CFD modeling abilities, such tools were applied to more complex systems, e.g. combustors; yet still agreements to within levels of 100 were acceptable.

In the past five years, advanced CFD abilities, chemical kinetics, diagnostics, etc., have resulted in an explosion of work exploring modeling methods for soot formation, its oxidation and particulate emissions. In selected cases, abilities to compute or approximate particulate size distributions from combustors have been developed. Highlights of this work will be reviewed, with discussion of strengths and weaknesses of such tools. In addition, prospects for better simulation tools will be discussed, including needs for estimating the impact of non-petroleum fuels on soot particulate emissions from gas turbine engines.

COMBUSTION EMISSIONS OF ALTERNATIVE JET FUELS

MR. EDWIN CORPORAN

Air Force Research Laboratory-Propulsion Directorate
1790 Loop Road N Building 490
WPAFB, OH 45433
(937) 255-2008
edwin.corporan@wpafb.af.mil

CO-PERFORMERS: Dr. Matt DeWitt and Mr. Chris Klingshirn
(University of Dayton Research Institute)

In recent years, the U.S. Air Force has been very active in the evaluation, demonstration and certification of fuels derived from natural gas and coal via Fischer-Tropsch (FT) synthesis, specifically, Synthetic Paraffinic Kerosene (SPK). To date, U.S. military aircraft such as the B-52, C-17 and B-1B have been certified for use of a 50/50 JP-8/FT blend. Other aircraft (i.e., F-22, KC-135, F-15, C-5, T-38) have already undergone flight tests and are scheduled to be certified on the FT blend in the near future. Certification of alternative fuels for use in aircraft, require extensive laboratory and large-scale evaluations to demonstrate aircraft system compatibility, proper engine performance and ensure no negative impacts on the aircraft mission and emissions.

This presentation provides a brief description of recent emissions evaluations of several test platforms operating with alternative jet fuel candidates from different feedstocks. FT fuels derived from coal and natural gas were evaluated on a T63 turbine engine and a CFM56 engine (NASA DC-8). A hydrotreated renewable jet fuel (HRJ) and several drop-in jet fuels derived from seed-oils were also evaluated on the T63 engine. In addition, the emissions of diesel engines (used to power R-11 and R-12 military refueling trucks) operated on JP-8 and a 50/50 JP-8/FT (natural gas derived) blend were assessed. For these efforts, jet fuel specification tests, chemical composition, particulate matter (PM) and gaseous emissions were measured. In general, the turbine and diesel engines operated satisfactorily with the alternative fuels. Test results show significant reductions (relative to the baseline fuel) in PM, carbon monoxide and unburned hydrocarbon emissions with the FT and HRJ alternative fuels for the diesel and turbine engines. These reductions on PM emissions were significantly more pronounced for turbine engines than for diesels. Statistically significant NO_x reductions were also observed in the diesel engines with JP-8 and the FT blend. The chemical characteristics, potential of these alternative fuels as drop-in replacements and observed deficiencies of these fuels will be discussed.

EVOLUTION OF AIRCRAFT ENGINE EMISSIONS IN THE ATMOSPHERE

DR. SCOTT HERNDON
Aerodyne Research, Inc.
45 Manning Road
Billerica, MA 01821
(978) 884-4787
herndon@aerodyne.com

CO-PERFORMERS: Ezra Wood, Zhenhong Yu, Michael Timko, Hsi-wu Wong, and Richard Miake-Lye (ARI); W. Berk Knighton (MSU); David Liscinsky (UTRC); Andreas Beyersdorf and Bruce Anderson (NASA)

Aircraft gas-turbine engines are different from most other combustion sources of emissions in that they use their exhaust in the atmosphere to provide the thrust, i.e. the work performed by the engine. As a consequence, the mixing, dilution, and chemistry in a gas-turbine engine exhaust is different from most other emissions sources. Recent work has examined how the gaseous and particulate emissions from gas-turbine engines evolve in the atmosphere by making measurements at the engine exit plane and downstream locations ranging from some tens of meters (30-50m) through over 100 meters (145m) to approaching 1 kilometer and more. The chemical evolution of hydrocarbons and NO_x provides insight into oxidative chemistry and its dependence on background ambient air composition. Data on the evolution of particles emitted demonstrate that on-going microphysical evolution significantly affects particle properties for the first few hundred meters in the exhaust plume, with contributions from sulfate, products of incomplete combustion of the jet fuel, and engine lubrication oil. The impact of alternative fuels on the emissions and their evolution will also be described.

TECHNICAL SESSION 4A

Topic: *Ecology and Management of DoD Coastal and Estuarine Ecosystems*

Chair: Dr. William Boicourt, University of Maryland – Center for Environmental Science

Keynote: Dr. W. Michael Kemp, University of Maryland – Center for Environmental Science

DoD assets include a number of installations that occur along the coastline. Some of these locations also are associated with estuarine ecosystems. The importance of these installations extends beyond their proximity and access to blue water. The physical features that define these areas—barrier islands, marshes, and shore-upland interfaces—are important backdrops for military training and testing. These ecosystems also contain significant biodiversity, are otherwise threatened by development outside the installation boundary, and are susceptible to additional adverse impacts from climate change. This session will address the current importance and vulnerability of these ecosystems, ongoing research that is investigating ecosystem-based approaches to understanding and managing these ecosystems within a military context, and future information needs associated with these ecosystems, especially under the threat of climate change.

| Session 4A - Ecology and Management of DoD Coastal and Estuarine Ecosystems | | |
|---|--|--|
| Time | Topic/Title | Speaker Organization |
| 8:30 – 8:40 AM | Welcome & Introduction by the Session Chair | Dr. William Boicourt University of Maryland |
| 8:40 – 9:05 AM | KEYNOTE: Chesapeake Bay Ecosystem: Decades of Degradation and a Road to Recovery? | Dr. W. Michael Kemp University of Maryland |
| 9:05 – 9:30 AM | Application of Advanced Indicators to Distinguish Military from Other Human and Climatic Impacts on Estuarine Ecosystem Function | Professor Hans W. Paerl University of North Carolina at Chapel Hill, Institute of Marine Sciences |
| 9:30 – 9:55 AM | Resilience of Ecosystem Services to Natural Physical Forcings vs. Human Interventions on a Coastal Barrier at Camp Lejeune Marine Corps Base | Dr. Charles Peterson University of North Carolina at Chapel Hill, Institute of Marine Sciences |
| 9:55 – 10:20 AM | BREAK | |
| 10:20 – 10:45 AM | Can Coastal Wetlands Survive a Higher Rate of Sea-Level Rise? | Dr. James Morris University of South Carolina |
| 10:45 – 11:10 AM | Gulf Coast Wetlands and Sea-Level Rise: Giving Them a Fighting Chance | Dr. Denise Reed University of New Orleans |
| 11:10 – 11:35 AM | Restoring Chesapeake Bay | J. Charles Fox U.S. Environmental Protection Agency |
| 11:35 – 11:45 AM | Discussion / Wrap-Up | |

KEYNOTE ADDRESS**CHESAPEAKE BAY ECOSYSTEM: DECADES OF DEGRADATION AND A ROAD TO RECOVERY?**

DR. W. MICHAEL KEMP

University of Maryland
Center for Environmental Science
Horn Point Laboratory
2020 Horns Point Road
Cambridge, MD 21613
(410) 221-8436
kemp@hpl.umces.edu

Serious degradation of many U.S. estuaries, including Chesapeake Bay ecosystem, began 50-100 years ago. Although there has been a wide range of human impacts on Chesapeake Bay and other estuaries (e.g., discharge of toxic contaminants, dredging of bottom sediments, and introduction of non-native species), the largest and most pervasive of anthropogenic effects are associated with over-enrichment of estuarine waters with nutrients and over-exploitation of fish and invertebrate populations through fisheries harvest. These human perturbations have been exacerbated by climatic disturbance associated with extreme storm events and longer term changes in temperature, stream flow, wind velocity, and sea level. Key alterations associated with coastal degradation include massive algal blooms, increased turbidity and loss of benthic photosynthesis, oxygen depletion and destruction of bottom habitat, and major changes in fish and invertebrate community structure. There are many difficult challenges in restoration of estuarine ecosystems. For Chesapeake Bay, these include reduction in nutrient inputs from diffuse watershed sources, recovery of oyster reefs and populations of other keystone species, and reversal of abrupt historical shifts in ecosystem structure and feedback loops that help to stabilize and sustain ecological services connected to human economy and well-being. Several recent examples, where tributary system water quality was improved through nutrient management and where fish populations were revitalized via harvest regulations, have demonstrated the potential for restoration through focused management efforts. It is becoming increasingly clear that effective recovery of estuaries like Chesapeake Bay will require integrated ecosystem management strategies that include restoration of ecosystem feedback loops that help to balance growth and diversity of valuable ecological communities.

APPLICATION OF ADVANCED INDICATORS TO DISTINGUISH MILITARY FROM OTHER HUMAN AND CLIMATIC IMPACTS ON ESTUARINE ECOSYSTEM FUNCTION

PROFESSOR HANS W. PAERL

University of North Carolina at Chapel Hill, Institute of Marine Sciences
3431 Arendell Street
Morehead City, NC 28557
(252) 726-6841, Ext. 133
hpaerl@email.unc.edu

CO-PERFORMERS: Professor Iris C. Anderson and Assistant Professor Mark J. Brush (Virginia Institute of Marine Science); Assistant Professor Michael F. Piehler and Associate Professor Rachel T. Noble (UNC-CH Institute of Marine Sciences); Dr. Carolyn A. Currin (NOAA-NOS Beaufort Laboratory)

Estuaries are among the most productive and resourceful aquatic ecosystems on Earth. They are also heavily impacted by both human activities and climate change. Symptoms of these stressors include eutrophication, an increase in harmful algal blooms and microbial pathogens, and habitat decline (hypoxia). Estuaries drain coastal watersheds containing >60% of the world's human population, a percentage likely to rise in the future. Estuaries are also prone to an upsurge in tropical cyclones and sea level rise. The Defense Coastal/Estuarine Research Program (DCERP) at Marine Corps Base Camp Lejeune (MCBCL), NC, is examining the interactive effects of human and climatic stressors on the composition, structure, function and sustainability of coastal and estuarine ecosystems. The semi-lagoonal New River Estuary (NRE) bisects MCBCL and is a vital feature of this coastal ecosystem. Using monitoring and research components, the Aquatic/Estuarine Module of DCERP is examining the effects of hydrologic, sediment and nutrient loadings on primary production, nutrient cycling, water quality, and habitat condition along the creek to mainstem continuum of the NRE from the freshwater head of the New River near Jacksonville to the tidal inlet at Onslow Bay. Using a set of strategically-placed monitoring stations, continuous flow-through sampling along the axis and shoals of the estuary, autonomous vertical profilers, and focused research projects utilizing a suite of novel microbial and biogeochemical indicators, the effects of hydrologic and nutrient/sediment impacts from upstream and downstream of MCBCL are being examined and evaluated. Water quality and habitat conditions and changes are strongly driven by seasonally predictable wet/dry periods and stochastic events such as major storms and droughts. Microalgal primary production and composition at the base of the NRE food web is sensitive to freshwater flow, nutrient inputs and turbidity. Nutrient enrichment bioassays indicate nitrogen is the nutrient limiting primary production. Therefore, the focus is on linking nitrogen (N) inputs from atmospheric and terrestrial sources to biogeochemical and water quality responses in the NRE using ecosystem-level monitoring and coupled modeling. Enhancing our understanding of planktonic and benthic microalgal responses to cycling of nutrients and changes in turbidity is essential for developing predictive models of the short- and long-term sensitivity of the NRE to changes in nutrient loading from hydrologic and human alterations, including military training activities, urbanization, agricultural practices, and nutrient management in the NRE watersheds and airsheds. This project provides decision-support indicators, modeling and criteria in support of ecosystem management.

RESILIENCE OF ECOSYSTEM SERVICES TO NATURAL PHYSICAL FORCINGS VS. HUMAN INTERVENTIONS ON A COASTAL BARRIER AT CAMP LEJEUNE MARINE CORPS BASE

CHARLES PETERSON

University of North Carolina at Chapel Hill, Institute of Marine Sciences
3431 Arendell Street
Morehead City, NC 28557
(252) 726-6841, Ext. 130
cpeters@email.unc.edu

CO-PERFORMERS: Dr. Stephen R. Fegley, Dr. Antonio B. Rodriguez, Dr. Janelle Reynolds-Fleming, Dr. Christine M. Voss, Beth M. VanDusen, and Dr. Richard A. Luettich, Jr. (University of North Carolina-Chapel Hill); Kasy L. Ray, Dr. Sarah M. Karpanty, and Dr. James D. Fraser (Virginia Polytechnic Institute and State University); Jesse E. McNinch (U.S. Army Corps of Engineers); Heidi M. Wadman (Virginia Institute of Marine Science)

Coastal barrier ecosystems experience physical environmental disturbances on multiple time scales, ranging from individual storm events to climate change. Drivers of physical disturbance include (1) natural and human-modified climatic-meteorological conditions and (2) human interventions into the geomorphological and sedimentological structures and physical processes. Consequently, a central research challenge for conservation ecology is to evaluate resilience to human-induced disturbances as compared to natural disturbances. In dynamic systems, defining and assessing resilience is problematic. Resilience alone may be an insufficient criterion on which to judge risk to ecosystem services without also including rate of recovery and potential management adaptations that could accelerate recovery.

Onslow Beach supports amphibious training by the Marine Corps Base Camp Lejeune, nesting by federally listed sea turtles, and ground-nesting and foraging by valued shorebirds and seabirds. Beach driving by amphibious terrestrial military vehicles compressed sediments and created tracks but had no effect on invertebrates of the wetted intertidal and no impacts on transit of sea turtle hatchlings. Beach disposal of spoils from Intracoastal Waterway dredging left a evident mound of unnaturally fine sediments on the back beach, which gradually eroded and was transported towards the southwest, as assessed by laser topographic monitoring. A coring study of biological impacts of this fill showed that the persistence of unnatural sediments over several months acted as a press disturbance to the benthic invertebrates, which suppressed recovery of these prey for shorebirds and surf fishes.

Natural dune-face erosion and overwash occurred in 2008 during a tropical storm and a northeaster. Such natural barrier island dynamics provide sparsely vegetated nesting grounds and foraging flats for shorebirds, marsh rejuvenation, and enhancement of fiddler crabs and other invertebrate prey. Abnormally high sea levels in 2009, provided insight into growing consequences of sea level rise, revealing the need for unconventional management of sea turtle nests, where drowning occurred on flooded back beaches where no egg excavation occurred. Inlet channel relocation could threaten the shoreline stability of Onslow Beach near New River Inlet. Long-term beach, shoreline, sediment, habitat, dune plant, and predator management need to be considered in the context of climate change to preserve and enhance ecosystem resilience.

CAN COASTAL WETLANDS SURVIVE A HIGHER RATE OF SEA-LEVEL RISE?

DR. JAMES MORRIS
University of South Carolina
Belle Baruch Institute
701 Sumter Street
Columbia, SC 29208
(803) 777-5288
morris@biol.sc.edu

CO-PERFORMER: Carolyn Currin (NOAA Beaufort Laboratory)

A model and supporting data will be presented that make a compelling case that homeostatic interactions among plants, sea level, and sediments maintain marsh surfaces in equilibrium with sea level, provided that the rate of sea-level rise (RSLR) does not exceed a tipping point. Salt marsh plant biomass and sediment accretion rates are functions of the relative elevation of the marsh surface. There is an optimum elevation for plant productivity, and there are upper and lower limits of relative elevation determined by hypoxia at one extreme and osmotic stress at the other. Provided that the marsh surface elevation is super-optimal for plant growth, a rise in relative sea level will stimulate primary production and sedimentation, thereby raising the surface elevation. Relative marsh surface elevation declines as RSLR increases. When the surface falls to a relative elevation that is suboptimal for the vegetation, a further increase in relative sea level depresses primary production and sedimentation, leading to the conversion of vegetated marsh to mud flat and open water. This transition is a tipping point and is influenced by the variability in RSLR. The model demonstrates that a marsh can be dynamically stable and will tolerate a greater maximum RSLR, provided that the rate is variable and declines periodically to a level that allows the marsh to recover. The model is being applied to coastal marshes at Camp Lejeune where currently two of three marshes being investigated are losing elevation. We have been able to reverse the loss of elevation by increasing plant growth by fertilization.

GULF COAST WETLANDS AND SEA-LEVEL RISE: GIVING THEM A FIGHTING CHANCE

DR. DENISE REED
University of New Orleans
Pontchartrain Institute for Environmental Sciences
New Orleans, LA 70148
(504) 280-7395
djreed@uno.edu

That coastal marshes are able to keep pace with sea-level is clear from geologic, historical and recent studies. Their ability to survive depends greatly on the rate of sea-level rise but also on the availability of key biogeophysical processes such as sediment deposition, organic accumulation, and tidal exchange. On the Gulf of Mexico coast various types of development activities have altered these processes. These effects can be direct, e.g., barriers to flow, fill, etc., or indirect. Indirect effects are frequently more difficult to quantify and their effect of the ability of marshes to keep pace with sea-level rise may be mediated through effects on plant growth and sediment availability rather than marsh accretionary processes. On the Gulf Coast due to the low tidal range and limited sediment supply from rivers, hurricanes and tropical storms, as well as more frequent cold fronts, provide most of the sediment for marsh accretion. This is often sediment mobilized from shallow bays or barrier beaches. Dredged channels, beach/barrier development, seawalls and bulkheads all limit the ability of these natural processes to redistribute sediment. However, activities that disturb sediment substrates make sediment more readily resuspended and available for transport during these events. Plant growth, both above and below ground, is influenced by flooding stress and nutrient availability, both of which are altered by commercial, industrial and military activities. Ensuring that coastal wetlands can adapt to future sea-level rise and continue to provide important ecosystem services for DoD installations requires an understanding not only of the rates of expected rise but of the local and regional management actions that can promote marsh accretion.