Coastal Response Research Center Funds New Projects for 2007

The Coastal Response Research Center (CRRC), a joint partnership between the University of New Hampshire and NOAA's Office of Response and Restoration, is pleased to announce funding for the following projects:

- Englehardt, J (University of Miami) "Development of a Predictive Bayesian Data-Derived Multi-Modal Gaussian Maximum-Likelihood Model of Sunken Oil Mass."

- French McCay, D. (Applied Science Associates, Inc) "Guidance for Dispersant Decision Making: Potential for Impacts on Aquatic Biota."

- Hollebone, B. and Wang, Z. (Environment Canada) "Investigation of Physical and Chemical Causes of Heavy Oil Submergence."

- Webler, T. and Tuler, T. (Social and Environmental Research Institute) "Social Disruption from Oil Spills and Spill Response: Characterizing Effects, Vulnerabilities, and the Adequacy of Existing Data to Inform Decision-Making."

For more information, please contact Amy Merten (amy.merten@noaa.gov). Abstracts for each project follow:

James D. Englehardt, PhD. (University of Miami)

Development of a Predictive Bayesian Data-Derived Multi-Modal Gaussian Maximum-Likelihood Model of Sunken Oil Mass

Abstract

The problem addressed in this proposal is the need for cost-effective tracking of sunken oil following a spill, to target cleanup activities and to support cleanup termination decisions. Sunken oil is difficult to "see" because sensing techniques (VSORS, ROVS) show only a small space at a point in time (Beegle-Krause et al. 2006). Moreover, the oil may re-suspend and sink with changes in salinity, sediment load, and temperature (Michel 2006), making fate and transport models difficult to deploy and calibrate when even the presence of sunken oil is difficult to assess. For these reasons, together with the expense of field data collection, there is a need for a statistical data-limited technique integrating field data collection with statistical fate and transport modeling. Predictive Bayesian modeling techniques have been developed and used by the PI to rigorously extrapolate desired information from limited available data in oil spill planning, hurricane, environmental, health, and safety risk analysis applications. For example, predictive Bayesian compound Poisson models have been developed for the U.S. Coast Guard to forecast changes in oil spill volumes (e.g., annual) arriving onshore around the Gulf of Mexico in response to proposed changes in oil transportation equipment and policies, given spatially-defined historical oil spill data, shipping routes and volumes, and hydrodynamic modeling results (Obie and Englehardt 1996; Douligeris et al. 1998). Significant advances in computational techniques such as Markov chain-Monte Carlo integration have increased the power of such methods further. In addition, modern genetic and other search algorithms and hardware can be brought to bear on the estimation of statistical parameters of highly-dimensional models such as may be obtained by superposition of Lagrangian (e.g., Gaussian) models. However, to our knowledge the approach has not been applied to the tracking of sunken oil or other pollutants.

The objectives of the proposed two-year project are to (1) compile and summarize data on the occurrence of sunken oil, directed by the project team including end users and NOAA liaison; (2) develop one or more superimposed, multi-modal predictive Bayesian Gaussian maximum-likelihood models of sunken oil locations across a bay that will accept spatial field data on sunken oil mass and hydrodynamic information from rapidly-deployable models of bottom and subsurface currents, to project assessments of sunken oil locations in time; and (3) verify the model versus sunken oil data, as possible, and simulated datasets. The approach is organized into three overlapping tasks: (1) "Development of conceptual model and data base," including a team kickoff meeting to identify data sources and define model capability, (2) "Model development," including the development of new genetic and other search algorithms for maximum-likelihood calibration of the model with field data, and (3) "Model verification, optimization, and dissemination," including active maintenance of a project website for information dissemination and model download and training activities as appropriate. The model(s) developed represent a new approach to oil and pollutant tracking in terms of the conceptual integration of maximum likelihood and search techniques with Lagrangian pollutant transport modeling, and the use of predictive (unconditional, marginal) Bayesian models capable of assessing sunken oil location based on limited available information with rigorous accounting of uncertainty. It is anticipated that the models developed will interface with current response, cleanup, and damage assessment models (e.g., GNOME, SIMAP) as appropriate, and be amenable to refinement and expansion to address a wider range of bathymetric conditions and potential tracking of suspended oil.

NOAA Liaison for this project: Christopher Barker (Chris.Barker@noaa.gov)

Coastal Response Research Center

Deborah French McCay, PhD. (Applied Science Associates, Inc.)

Guidance for Dispersant Decision Making: Potential for Impacts on Aquatic Biota

Abstract

The proposed research addresses the major priority area identified in the Coastal Response Research Center (CRRC) RFP "Biologically/Ecologically-Driven Spill Response", specifically identifying the timing and nature of trade-off decision points in the context of response activities and expected level of resource injury. This project will provide responders with a quick guide allowing them to determine the likely water volume adversely affected by naturally- or chemically-dispersed oil and dissolved hydrocarbons, as well as the surface area impacted by floating oil, with which they can evaluate tradeoffs of dispersant use and plan monitoring activities, including for natural resource damage assessment.

It is well understood that direct measurement of water column effects from naturally and chemically dispersed oil is extremely difficult, if not impossible, because of the inherent patchiness of concentrations and water column organisms and the ephemeral nature of the subsurface plumes. The spatial and temporal scales of patches with potentially toxic concentrations are typically on the order of meters to kilometers and hours to days. Thus, modeling is the most productive method for estimating water column acute toxic effects from dispersed oil. Modeling also provides estimates of areas swept by floating oil and shoreline oiled, within which wildlife and shoreline habitat injuries would occur.

The Oil Spill Impact Guide (OSIG) will be based on a matrix of 240 model runs using ASA's SIMAP physical fates, exposure and oil toxicity models, where key variables determining impact are varied: oil type, weathering state, oil volume, environmental (e.g., wind speed, temperature) conditions, dispersant use, and toxicity to aquatic biota. The key model results from these runs will be the volume of water where acute toxic effects would occur and the area of water surface oiled (which would impact wildlife, as well as socioeconomic uses). Model results from the matrix will be summarized in both tabular and chart format so that users of the guide can look up the order of magnitude of likely impact and interpolate between results for intermediate conditions to those run in the matrix of scenarios. Simple regression equations will be provided to facilitate such interpolations for intermediate volumes of oil spilled and dispersed. The guide will be in three forms: as a report describing the approach, assumptions and results of the modeling and guidance development; a field guide in paper/PDF format; and a calculator in spreadsheet format that will facilitate interpolations.

The research and lessons learned from this effort will contribute to national efforts aimed at developing decision-making tools and supporting information related to spill response, and specifically with respect to dispersant use. The results of the research will be presented and explained to the spill response community during or adjunct to a spill-response related meeting or conference. The presentation will be part of a focused half-day workshop on dispersant decision-making, where discussion of the results and implications will be solicited. The seminar will include presentation of the Oil Spill Impact Field Guide and calculator. The Oil Spill Impact Guide will be freely available on the web.

NOAA Liaison for this project: Troy Baker (Troy.Baker@noaa.gov)

Bruce Hollebone, PhD. (Environmental Science and Technology Centre, Environment Canada)

Investigation of Physical and Chemical Causes of Heavy Oil Submergence

Abstract
This proposal is derived from the CRRC research needs assessment: Submerged Oil – State of the Practice and Research Needs. Our objectives are i) to examine the causes and effects of density changes in heavy petroleum oils that cause just-buoyant oils to become overwashed and sink at sea and in fresh water, and ii) to examine the physical and chemical causes for refloatation of heavy oils. The proposed work includes both simulation of spills at the bench-scale and examination of real samples of submerged oil from spills of opportunity. The factors affecting oil submergence to be considered include: temperature, solid-phase uptake, water uptake (and emulsification), evaporation and photo-oxidation. This work will lead to a better understanding of the micro-changes in oils and their environments that lead to submergence of oils. This is expected to benefit both the spill modelling and spill response communities. This proposal aims to directly address the research needs D1 and D3 of the CRRC needs assessment and to contribute to research needs E1, E7, and E9.

NOAA Liaison for this project: Robert Haddad (Robert.Haddad@noaa.gov)

Coastal Response Research Center

Thomas Webler, PhD. and Seth Tuler, PhD. (Social and Environmental Research Institute)

Social Disruption from Oil Spills and Spill Response: Characterizing Effects, Vulnerabilities, and the Adequacy of Existing Data to Inform Decision-Making

Abstract

Oil spill response planners never disregard the human dimensions of oil spills. In fact, the National Contingency Plan requires that items of economic and environmental importance that are threatened by a spill be covered in the plan. However, the strength of ecological concerns and the wealth of information on ecological sensitivity tend to be primary drivers in contingency planning. The socioeconomic lags behind the ecological in terms of readily available information and tools to assess sensitivity. Social endpoints that are acutely threatened are protected in an emergency response, but the systematic assessment of social and economic effects is not widely done in area-based contingency planning processes. This research project investigates what is involved in bringing a systematic assessment of socioeconomic vulnerability considerations into area-based oil spill contingency planning. While this project has one eye on the ultimate goal of producing practical decision-support or social impact assessment tools, it presupposes that several types of information need to be collected, evaluated, and synthesized before such tools can be constructed. Specifically: (1) human dimensions endpoints threatened by oil spills need to be systematically identified; (2) the relationships between these endpoints, effects, and planning and management actions should be evaluated; (3) the sufficiency of existing data and data-analysis tools to characterize and anticipate these causal relations must be assessed. Initial inquiries with emergency responders and contingency planners into these questions have validated their importance.

Drawing on existing data wherever possible, we propose to review qualitative data to reveal the types of human dimensions endpoints that matter in oil spills. In Phase 1, we will document how the importance of endpoints can be understood and, eventually, measured using the conceptual framework of vulnerability. We will meet with experienced personnel as part of three case studies to identify endpoints of concern and use the conceptual framework of vulnerability to identify key factors influencing losses. The information we gather will be structured in a way that facilitates planning interventions. In Phase 2, we will investigate to what extent existing data are capable of depicting the human dimensions considerations identified in Phase 1 and we will propose recommendations for how a planning process that has been strongly led by ecological considerations can be broadened to also include the most important human dimensions. These recommendations will also summarize how oil spill planning can proceed using a perspective that highlights the coupled human and natural systems.

NOAA Liaison for this project: Ed Levine (Ed.Levine@noaa.gov)