CRESP UPDATE: SAVANNAH RIVER

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Inside

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CRESP at Year Four

by Charles Powers, Ph.D.

The CRESP Task Groups working on environmental issues at the Savannah River Site are well aware that their research is being done at a site that is different from many others in the Department of Energy complex. For many other sites, the focus is on how environmental cleanup obligations can be met so that they can be closed and/or returned to non-DOE uses. Our work shows that the DOE's plans for SRS to pursue ongoing missions related to nonproliferation and defense is largely supported by SRS stakeholders. They support site activities that continue to generate economic and other benefits so long as SRS does not become simply a place to store waste. The public seems to trust site operations when SRS remains a vibrant place where risks are actively managed. The available data also suggests that SRS poses very modest short-term risks. Nevertheless, there remain major challenges to site restoration and the management of waste and facilities from the Cold War era and to safe operation of ongoing operations.

For that reason, CRESP research has attempted to address stakeholder concerns about that legacy. It has worked to augment available data to help better forecast the pathways for contaminants — and the pace, probability and consequence of movement through those pathways — that may pose longer term risks. Some work has focused on understanding the complex physical movement of contaminants in the specific SRS terrain; other work has attempted to understand whether and, if so, how contaminants are moving or might move through the food chain. And because stakeholders are vitally concerned with economic risks, some CRESP researchers have sought to forecast the effects on economic and other social interests of investments designed to address both the several SRS missions and the environmental challenge.

Since the pathways of concern are those which lead to receptors (people or ecological), it has been important to try to forecast where those receptors are now or will "be" under different land use options. Research designed to forecast the likelihood and consequence of what may happen is meaningful when it is communicated in a way that stakeholders understand why it matters. That means reporting results in a way that helps both risk managers and stakeholders actually see what risks may emerge and what alternatives are available to reduce hazards. And this must be done without overstating or understating what risks they may pose. If risks are credibly identified early, alternative approaches to addressing them are well considered, remedial activity is effectively ordered and the results of real risk reduction regularly communicated, public confidence is maintained. CRESP seeks to be a part of the overall effort to provide that kind of information. This specific issue of the *CRESP Update* is designed to provide a quick summary of many of those CRESP projects.

Data Characterization, Analysis and Statistics

As part of the Task Group's ongoing work on the epidemiology of radiation workers at the Savannah River Site, we are reviewing the published literature on cancer mortality of radiation workers. The goal of the study is to understand whether deaths from any type of cancer are more common among radiation workers than the general public, and to assess the consistency and homogeneity, or similarity, of studies addressing this topic. More than a dozen different cohorts, or groups, have been studied worldwide. The review will cover studies on workers in the U.S., Canada and the United Kingdom. Previous summaries of radiation worker mortality have pooled individual data from studies of different cohorts. This enabled the researchers to have greater specificity in their analysis and to assess patterns of dose-response. The most recent publication was coordinated by the International Agency for Research on Cancer (IARC) and an update is in progress.

The DCAS approach is to apply meta-analysis methods to the published results. Meta-analysis is a method that synthesizes research results that focus on the same questions from many sources. While this approach does not allow for the same in depth consideration of dose-response as the pooled approach, it does enable researchers to use published data for which the individual data are not available. The results should complement those of the IARC studies.

One such study underway by this Task Group (*CRESP Update*, May 1997) follows up the 1995 work by Cragel for the National Institution of Occupational Health and Safety (NIOSH) which found a suggestion of a link between radiation exposure and leukemia deaths. The CRESP study uses the data from this work to investigate stakeholder concerns that these deaths may be linked to tritium exposure. We are currently characterizing the overall patterns of mortality including a profile of tritium workers. Additionally, we are planning to characterize the mortality patterns of women and minorities. These two groups were not included in the Cragel study. This work was facilitated by a data sharing agreement between CRESP and NIOSH. For more information , contact Daniel Wartenberg at dew@eohsi.rutgers.edu or 732-445-0197.

Ecological Health

The mission of the Ecological Health Task Group is to develop methods for understanding biodiversity at all levels, including individual, population, community, ecosystem and landscape. Such understanding requires indicator and index measures at all levels, as well as evaluating how ecological resources are used and how to restore ecosystems. Indicators are species that can reflect a measure of ecological and human health. In addition to their ecological importance, such information is critical for compliance, cleanup, remediation and restoration.

The Ecological Risk Task Group is engaged in projects at several levels to identify indicators of biodiversity — from organisms to landscape scale effects. Our work with indicators includes mourning doves, wood ducks, and raccoons that represent the range of levels of the food chain. These species were selected because they are common on DOE sites, are indicative of species and population effects within ecosystems, and are consumed by humans. They represent the development of indicators that can be used to assess both ecological and human health.

It is equally important to develop and refine measures of ecosystem and landscape effects, and these should be able to detect differences in both physical and chemical disruptions, as well as biological disruptions. CRESP is engaged in developing and modifying the Index of Biotic Integrity (IBI) for fishes and amphibians (CRESP-EOHSI) and for plants and insects (CRESP-UW).

Two other projects of this Task Group are aimed at understanding ecosystem and landscape effects. Dr. Joel Snodgrass, Savannah River Ecology Lab (SREL), is studying habitat alterations and small reservoir effects on fish assemblages at SRS. This study involves comparing samples of fish in small streams before and after a nuclear cooling reservoir was constructed on one of the streams to determine its effect on fish assemblage structure. We used samples collected in Steel Creek and from three reference streams that were similar, nearby, and undisturbed before and after construction of the cooling reservoir on Steel Creek in 1985. Fish were sampled before the construction of Steel Creek in 1985, and again in the spring of 1997. This project's importance is in the development of a methodology to assess physical and chemical disturbances to streams by cooling reservoir development. This type of disruption is present not only on DOE sites, but at a number of other industrial sites throughout the U.S.

Fish assemblages experienced a greater change in Steel Creek than in the reference streams. Upstream

species guilds (groups of similar species) decreased, and downstream guilds increased in abundance following construction of the reservoir on Steel Creek. To test whether these differences were due to water quality or contaminants now present, we caged one species of fish in Steel Creek and a reference stream for 39 days, and found that there were no differences in growth or survival. This suggests that these changes in species diversity were not due to present water quality variations.

We conclude that upstream and downstream fish guilds can be useful in detecting risk from human impacts to stream systems. The first phase of this research is in press in the *Canadian Journal of Fisheries and Aquatic Sciences*.

An additional project using landscape ecology metrics for assessing ecological risks is being conducted at Oak Ridge Reservation in Tennessee led by Steve Bartell, CRESP-UW. The development and operations of DOE facilities have physically altered both local and regional landscapes, and off-site alterations have resulted from urbanization stimulated in part by DOE. In this study we examine historical landscape changes both on Oak Ridge and nearby landscapes.

We digitized U. S. Geological Survey quadrangle maps from the early 1940s and 1990 to assess spatial changes in land use over this 50-year period by using a comprehensive set of measures that describe spatial changes. Analysis of these indices show that during these 50 years the landscape has become more forested and less fragmented within Oak Ridge. In contrast, outside the Oak Ridge boundaries, continued urbanization has produced a highly fragmented landscape. The major changes within Oak Ridge occurred primarily from the early 1940s to 1953, while changes outside the boundary have been more continuous.

Future phases of this project will examine the relationship between larger scale alterations and habitat suitability for selected species of wildlife on Oak Ridge. Ultimately these measures of landscape change will be useful for other DOE sites, as well as for examining change in a range of other disrupted landscapes. These results are being prepared for an ecological journal.

Both of these projects are aimed at developing methods that have general applicability for DOE sites, and for assessing the relative effect of DOE operations within their ecological regions. The projects are ongoing, and we welcome any comments on any aspect of our work. For more information, contact J. Burger at burger@biology.rutgers.edu or 732-445-4318.

Exposure Assessment

The Exposure Assessment Task Group is continuing to work on projects that cover a wide range of issues. Several of these projects are done in collaboration with other CRESP Task Groups at EOHSI and UW. The projects can be broadly classified into five focus areas: development and application of software to manage and analyze environmental data, development of methods to solve inverse problems (such as the calibration of models), environmental process, biological process, and integrated environmental exposure modeling and data analysis. Projects in the first two of the focus areas will provide tools to be used in conjunction with the environmental, biological, and exposure modeling projects.

A major focus of the Task Group work is on the prediction of potential future exposures. This requires the capability to predict future concentrations of chemical and radiological contaminants in environmental media like groundwater, surface water and air, and to describe the interaction of these media with potentially exposed populations. To predict environmental concentrations of contaminants in the future, an accurate knowledge of current environmental concentrations and of relevant transport and transformation processes is needed. Predictions of the future are inherently uncertain. To be more accurate in describing the possible concentration of contaminants, a range of values and an associated confidence estimate is typically provided rather than simply a point estimate of future concentrations.

Even more preferable than a given range of values is a probability density function (pdf) that associates a probability, or likelihood, (which could be any number between 0% and 100%) with a user specified range of values. Creations of these pdfs are commonly done using a technique called the Monte Carlo method. To employ this kind of technique, thousands of simulations are usually necessary, and it is often impracticable to employ this technique with some of the complex models used in the assessment of environmental contamination, due to time and computational constraints. Task Group research has led to the development of alternative methods of uncertainty propagation that are much more efficient than Monte Carlo-based methods. It is now possible to generate pdfs for the results of many complex models previously impossible to create.

Another major focus area is the integration of all of the computer-based models involved in describing the sequence of events leading to exposure. These are release from source, environmental transport and transformation, contact with receptors, biological transport and transformation, and target tissue dose. Since the description of the sequence of events leading to exposure requires a wide range of expertise, the

modeling of different events in the sequence is usually conducted by personnel with different backgrounds and training. Therefore, there is a potential for information to be lost in the transition from one modeling group to another. To address this problem, we are developing a modeling framework comprising a library of modules for exposure modeling and analysis, including the modeling of environmental transport and transformation. At the heart of the system is a Geographical Information System (GIS) to manage, visualize, and analyze input and output model variables and data. The modular nature of the framework will allow the generation of inputs for a variety of alternative models, using the same basic data, thereby ensuring their consistency. This will provide an efficient means of testing the effect of adjusting assumptions used to create alternative models. A prototype of the framework has been developed and applied to TCE contaminated groundwater at the A- and M-Areas of SRS. The prototype employs a groundwater and contaminant transport microenviromental model (MODFLOW-T) to predict the indoor air concentrations from household use (other than drinking) of the contaminated water, and also employs a complex model to estimate inhalation and dermal uptake by residents of the household. For more information, contact Amit Roy at amitroy@fidelio.rutgers.edu or 732-445-0108.

Health Hazard Identification

This Task Group continues to develop projects that help to understand health effects associated with contaminants found at SRS. New efforts are underway to evaluate the effects of chemical and radionuclide mixtures found at SRS. This is a difficult task because multiple chemicals and radionuclides are found in water, soil and air. Both people and wildlife may be exposed. Contaminants that move through the environment together, or are frequently found in environmental samples such as fish or wildlife, are likely candidates for this evaluation.

One ongoing study by Dr. Ed Yurkow, Health Hazard Task Group member, looks at how the induction of specific proteins changes when two metals are mixed together. This will lead to a better understanding of the toxicity of combinations of metals.

Another effort in the planning stages is to examine the toxicity of a mixture of cesium and mercury. These contaminants have been found together in fish samples and understanding the toxic effects of this combination will help to determine the risks associated with consumption of fish. An additional project determines the bioavailability of mixtures of metals and radionuclides in soil. If a contaminant is not bioavailable, or does not enter a biological system, it cannot be toxic. This research will also help to understand the risk associated with soil contamination. This Task Group hopes to use this information in future estimates of contaminant risk at SRS. For more information, contact Lynne Fahey McGrath at lmcgrath@eohsi.rutgers.edu or 732-445-3287.

Outreach and Communication

Two CRESP-EOHSI members, Lynn Waishwell and Lynne Fahey McGrath, Health Hazard Appraisal Task Group, are participants of the Risk Working Group of the SRS-CAB Risk Management and Future Use Subcommittee, a group recently initiated to examine risk and risk communication processes at SRS.

Recently Lynn Waishwell, Director of Outreach and Communication of CRESP-EOHSI, accompanied the CDC-SRS Health Effects Subcommittee on a daylong tour of SRS. The group visited the L Area and several monitoring stations along the Savannah River.

Several staff members of the Ruth Patrick Science Education Center at USC-Aiken and a Westinghouse scientist were funded by CRESP to be trained on a new award winning curriculum developed by the EOHSI Resource Center. The curriculum, Toxicology, Risk Assessment and Pollution, or ToxRAP ™ for K-8 students teaches basic applied science through a risk assessment framework. The Center will offer training for K-3 and 4-6 students at an annual science teachers conference in November. Any teachers who are interested in learning more about the curriculum or availability of training can contact the Ruth Patrick Science Education Center directly or Lynn Waishwell, Director of Outreach and Communication of CRESP.

Lynn Waishwell worked with Karen Lowrie of the SLUDGE-EOHSI group to understand how newspapers from communities near SRS and Rocky Flats, Colorado, report site activity and how the risks and hazards are characterized. Newspaper articles published in

The Augusta Chronicle, The State and the Atlanta Constitution between July 1, 1996 and June 30, 1997 from the SRS area were examined to learn the sources of information, main subjects and the impacts addressed. The most frequently used source of information from both sites was from DOE: contractors, local or DOE-Headquarters in Washington. Risks were not often mentioned. In the newspapers related to SRS, 3.9% of the paragraphs identified a risk related to a site event or situation. For more information or a copy of a report, contact Lynn Waishwell at lwaishwe@eohsi.rutgers.edu or 732-445-0220.

Remediation Technology

The primary activities of the Remediation Task Group currently are focused on three areas: 1) the prediction of tailing effects during groundwater and vadose zone remediation, 2) defining "background" contaminant levels in soils and groundwater, and 3) measurement of radionuclide mobility in SRS soils. Many of these activities are being carried out in close cooperation with the Exposure Assessment Task Group.

Once the remediation process has begun and some large portions of the contaminant have been removed, it becomes difficult to predict how much more time is needed before the remediation can be stopped. This "tailing" is observed during implementation of remediation processes and is often excessive. It occurs, for example, in soil vapor extraction and groundwater recovery, for a vadose zone (the area between the ground surface and the water table) and groundwater remediation. In these cases, tailing refers to the extremely long time interval required to achieve significant reduction in contaminant concentration after an initial period of rapid contaminant recovery. Often viewed in terms of diminishing returns from remediation process operations, this phenomenon can result in a large fraction of the contamination (ca. 85%) being recovered in a very small fraction of the time required for removal of the remaining contaminants to achieve clean up standards. Current process design, economic evaluation, and risk assessment models poorly predict or account for this phenomenon. The result can be a substantial underestimation of remediation time frames, costs, and achievable endpoints. Tailing phenomena most often results from large disparity in the time scales for contaminant desorption and mobility in different structural regimes within the subsurface. This may be caused by slow diffusion rates in soil micropores and larger scale (e.g., inches to feet) heterogeneity within subsurface layers. The CRESP Remediation Task Group is currently carrying out laboratory experiments, reviewing field information, and improving mathematical models to evaluate the impact of this phenomenon on remediation activities at SRS. This activity includes consideration of TCE (trichloroethylene) contamination in the vadose zone and mixed radionuclide contamination at some old infiltration basins that require remediation.

CRESP is currently working on development and application of geostatistical techniques to define background species concentrations in surface soils and groundwater. CRESP is carrying this out in cooperation with SRS teams responsible for remediation and management of SRS environmental databases.

A mechanistic and quantitative understanding of radionuclide mobility in surface soils, sediments and the vadose zone is important to predicting the spread and remediation of radionuclides, as well as the uptake of these contaminants through the food chain. Well defined and quantified mechanisms of interaction between specific radionuclides and the geologic materials present at SRS will permit application of methods to reduce mobility and to improve remediation techniques. The observed mobility of a specific radionuclide also is a function of the time over which the contaminant has been present in the soil and the local microenvironment (e.g., oxidizing or reducing conditions). Cesium-137 is of particular interest at SRS because of its prior dispersal in soils and sediments. It is frequently a significant component of estimated risk. CRESP currently is carrying out laboratory measurement of cesium and other radionuclide mobility for a range of soil types at SRS. These laboratory results are being compared to observed radionuclide mobility at infiltration basins at SRS. Additionally, through cooperation with European researchers, we are comparing cesium mobility found at SRS with other off-site releases of cesium such as that which occurred in Chernobyl. For more information, please contact David Kosson at kosson@sol.rutgers.edu or 732-445-4346.

Social, Land Use, Demographic, Geographic, and Economic

In a recent Task Group project that surveyed more than 60 local planners, interviewees reported that communities are most concerned about economic impacts of the sites and secondarily about environmental impacts. Planners reported low levels of involvement in site decision processes, and that their rating of residents' trust of DOE information is low. A follow-up survey of 26 financial officers

again revealed that downsizing is hurting local economies and affecting property values at some sites. Industrial reuse or continued nuclear uses were rated highly as future uses of the sites.

Also concerned with economic impacts of DOE sites, the report, *Demographic and Economic Characteristics of Areas Surrounding Small DOE Sites*, presents an analysis of populations in census tracts surrounding 75 of DOE's smaller sites, including those in the Formerly Utilized Sites Remedial Action Program (FUSRAP) and Uranium Mill Tailings Remedial Action (UMTRA) programs, and a set of smaller major sites. Distinct differences between sites by administrative program were found: FUSRAP being the most urban and UMTRA the least. Most important, differences in racial/ethnic composition and socioeconomic status between site areas and their surrounding counties that suggest the potential for environmental justice issues were identified.

Additionally, the Task Group is currently working on an evaluation of the economic impacts of the DOE Environmental Management accelerated clean up budget and of expanded recreation at SRS on the regional economy. We are also developing of a set of leading economic indicators for the SRS region, and examining land use and stewardship at the Rocky Flats site in Colorado that will be followed by a resident survey later this year.

Ongoing projects include site visits and interviews at the small sites, focusing on effective public participation in remediation issues, and a study of economic development strategies at the three large, rural sites - SRS, Hanford and the Idaho National Engineering and Environmental Laboratory. For more information, contact Michael Greenberg at mrg@rci.rutgers.edu or 732-932-0387, extension 673.

Worker Safety and Health

This Task Group has focused much of its attention on the hazards and protection of environmental remediation workers at the DOE sites. Two in depth studies, one at the small Paducah Gaseous Diffusion Plant in Kentucky and the other at the Savannah River Site, have revealed some of the different ways that worker protection is accomplished as well as potential limitations that should be addressed.

A collaborative study conducted by CRESP at EOHSI and the University of Washington (UW) examined the structure and function of occupational medical services across ten DOE sites. Some of the sites have large occupational medicine departments and large health physics or radiation protection departments. Historically industrial hygiene departments have not been as well developed. We found that the industrial hygiene staffs were much smaller than the health physics staffs. When assessing potential needs for workers, much of the required cleanup involves both chemical as well as radioactive waste. We have found that cleanup workers probably have adequate access to health physics to minimize their exposure to radiation, but inadequate access to industrial hygiene that would minimize their toxic chemical exposures.

The major risks to remediation workers probably come from more general construction or industrial-type accidents like falls, crushes, electrocutions and other traumatic injuries. We were impressed that the DOE has in place an elaborate system of permits and approvals which require training and protection of remediation workers — even those employed by lower tier subcontractors. However, accidents happen and even occasional fatalities. Data indicate that the rates of injuries vary across sites, and that for the prime contractors the injury rates are lower than the average industrial accident rate. This is not true for subcontract employees. Our future research will investigate this discrepancy. Is it because the subcontractors perform work that is intrinsically more hazardous, or is it because of inadequacies of their health and safety programs?

The assessment of worker health and safety would be abetted if there were a comprehensive registry of remediation workers. This would allow us to calculate rates of injury, or even illness, for particular types of jobs on particular sites. Records of former DOE-site workers are incomplete, and the Department is now investigating ways of identifying former site workers. Although records of current prime contractor employees are good, there has been no formal registry for subcontractor workers. This could impose a future requirement of trying to reconstruct this more itinerant workforce. Thus, CRESP sees the need to encourage DOE to develop its registry of subcontractor workers beginning now. We have already demonstrated the feasibility of registering subcontractors who perform construction work, and are pursuing ways of identifying those whose contracts are identified as service rather than construction.

Finally, in discussion with the Environment Safety and Health Division of DOE, we have identified the need to provide training for clinicians in the vicinity of DOE sites, in order to enhance

their ability to evaluate and protect both workers and neighbors of DOE sites.

Dr. Michael Gochfeld, Task Group Leader, and Dr. Paul Seligman, Deputy Assistant Secretary, Environment, Safety and Health Office, DOE, delivered a prototype curriculum at the April 1998 American Occupational Health Conference in Boston, which was attended by physicians from around the nation. The presentation was highly successful with excellent interchange from the audience, and the evaluation scores were very high. The curriculum made use of some of the recent CRESP research developments. The next step is to modify the curriculum, expand it for nurses, and to deliver it to both nurses and physicians at the next annual conference. This will be done by Gail Buckler R.N. and Sandra Mohr M.D., Worker Safety and Health Task Group members. The intent is to develop a core curriculum that can be distributed to sites so that the course can be implemented periodically, supplemented with site-specific material, to clinicians around each site. For more information, contact Michael Gochfeld, gochfeld@eohsi.rutgers.edu or 732-445-2917.

Other Notes

Presentations

In response to a request from the SRS Risk Management and Future Use Subcommittee, Dr. Bernard Goldstein, Principal Investigator of CRESP, presented a workshop on the fundamentals of risk assessment to the recently formed Risk Working Group. Approximately 35 people were in attendance, including about ten members of the Working Group that consists of CAB and community members. The presentation was videotaped, and will be available from Lynn Waishwell at CRESP-EOHSI.

SCOPE meets at EOHSI

The Tenth General Assembly of the Scientific Committee on Problems of the Environment (SCOPE) was hosted by the Environmental and Occupational Health Sciences Institute (EOHSI), in Piscataway, New Jersey, in mid-June. Dr. Bernard Goldstein, Principal Investigator of CRESP and Director of EOHSI said it was an honor for SCOPE to be held at EOHSI since it brings international recognition to the institute among world leaders.

The first focus of this year's meeting was on "New Jersey as a Microcosm." Joanna Burger, Ph.D., Ecological Health Task Group Leader of CRESP-EOHSI, organized the session on New Jersey. Several hundred delegates from 39 nations heard how New Jersey serves as a laboratory for environmental problem solving in other parts of the United States and the world. New Jersey's high population density (more than 1000 people per square mile; highest in the U.S.) coupled with a concentration of heavy industry has forced the state to face environmental problems that are just emerging elsewhere. New Jersey experiences also illustrated the issues presented in symposium's second focus on "The Commons Revisited: An American Perspective."

SCOPE is a nongovernmental organization of scientists established in 1969 by the International Council of Scientific Unions to provide independent, scientific input on environmental problems that are inherently interdisciplinary and international. Every three years SCOPE conducts a general assembly, scientific symposium, and reevaluation of the scientific program. In 1995, Tokyo was the site.

Lester Brown, Director of the Worldwatch Institute, gave the keynote address at the one-week session. He is considered one of the world's most influential thinkers and a guru of the global environmental movement.

CRESP

The Consortium for Risk Evaluation with Stakeholder Participation (CRESP) is a university-based national organization created specifically to develop a credible strategy for providing information needed for risk-based cleanup of complex contaminated environments, especially those for which the Department of Energy is responsible. The Consortium specifically responds to the request by the Department of Energy and the National Research Council for the creation of an independent institutional mechanism capable of integrating risk evaluation work. As a result of a national competition, a five-year cooperative agreement was award to CRESP in March of 1955. The *CRESP Update* is one approach that we are using to share research plans and programs with SRS stakeholders.

CRESP Information

If you would like information about CRESP or any of the activities described, contact Lynn Waishwell, Director of Outreach and Communication, at 732-445-0920. She would be happy to facilitate your dialogue with Task Group leaders.

Please visit our website
www.cresp.org

CRESP Update

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