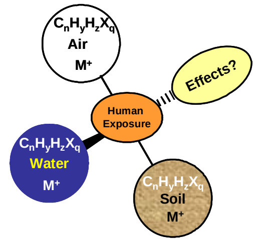

Superfund Research Program
University of California, Davis

Dr. Bruce D. Hammock, Director

Research Update No. 3 **May 2010**

Introduction

The primary purpose of this Research Update is to inform staff in State and Federal government involved in legislation and regulation of toxic substances in the environment about research results emanating from the UC Davis Superfund Program. The goal of these updates is to provide information about the National Institutes Environmental Health Sciences (NIEHS) funded Superfund Research Program (SRP)[1] that has been at UC Davis for the past 24 years. Additionally, others involved in the mitigation and assessment of toxic substances in the environment may find some value in these updates. This national program was initiated to address human and environmental problems such as Love Canal, NY where improper disposal of chemical wastes occurred or Imperial, MO where oil containing chlorinated dioxins was sprayed on roads as a dust suppressant. The mission of the SRP is stated below[2]

> "*Since its inception in 1987, the SRP has applied a multidisciplinary approach to basic research focused to provide a solid foundation which environmental managers and risk assessors can draw upon to make sound decisions related to Superfund and other hazardous waste sites. We believe that basic research plays a crucial role in addressing challenges posed by environmental contamination such as health risks, toxicity, exposure predictions, fate and transport, and the need for c*ost-effective treatments for hazardous *waste sites found throughout the United States"*

The Superfund Research Program at UC Davis[3] has provided basic research information to address these needs. We continue to develop innovative, novel technology to investigate human exposures, environmental fate and transport of toxic substances, as well as cost-effective methods for the treatment and remediation of these chemicals in the environment. The success of our program relates to the breadth of the multidisciplinary approach to these complex scientific issues of chemical exposure that continue to pose hazards to human and environmental health.

This program exports its findings beyond academic journals and publications to other venues and audiences. We have concerted efforts to effectively partner with government, transfer technology to commercial ventures, and communicate with broader public audiences for the purpose of improving human and environmental health. Research Translation of scientific results is important for society's understanding of the goals of the SRP in the mitigation of toxic substances in the environment.

Results

This Research Update highlights three relevant areas of research from the program: 1) Antimicrobials in the news: triclocarban and triclosan, 2) Modeling of contaminant movement and degradation in groundwater, and 3*)* Rapid evaluation of chemical toxicants*.*

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[1] Name changed from Superfund Basic Research Program to Superfund Research Program in 2008
[2] www.niehs.nih.gov/research/supported/sbrp/about/index.cfm
[3] www-sf.ucdavis.edu/

Antimicrobials in the News: Triclocarban and Triclosan

Background

Recent reports in the press have highlighted concerns about the occurrence of these antimicrobials in the environment and the potential for human exposure that may result in toxicological effects. When the antibacterial properties were discovered in the 1960s and ‘70s they were added to soaps and toothpaste. Annually triclocarban and triclosan enter the ecosystem at 600,000 – 10,000,000 kg/annum from Waste Water Treatment Plants (WWTP). Recalcitrance to degradation at WWTP results in high sediment contamination and environmental persistence because they are tightly bound to the biosolids associated with the WWTP processes. In a collaborative project between three SRP-supported universities, UC Davis, UC San Diego and Arizona State University, researchers investigate novel methods for detection, effects on aquatic biota, potential hormonal effects, *in vitro* effects on receptors in the heart, methods for human biomonitoring, environmental persistence, degradation and fate.

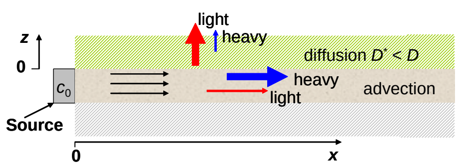
Impact

The wide ranging nature of these studies with triclosan and triclocarban provide new, essential information to better define the environmental degradation, fate effects and human exposure of these antimicrobials. These data are useful to regulatory agencies such as the US Environmental Protection Agency and the Food and Drug Administration.

Groundwater modeling of contaminant movement and degradation

Background

Contamination of groundwater in the United States by natural and man made contaminants is widespread. Understanding of the movement and degradation of contaminants is essential for the protection of domestic water supplies and estimation of exposure risks. UC Davis researchers have developed and applied new characterization and modeling methods, some of which are being officially adopted by the U.S. Geological Survey, to more accurately describe the movement of contaminants in groundwater. In addition to understanding contaminant movement, degradation rates of certain contaminants must be assessed. Dilution of a contaminant in groundwater, as a plume migrates in the typically complex subsurface, may lead to the erroneous perception that contaminants have undergone degradation. Hence, it is important to differentiate effects of physical transport processes from biological or chemical transformation. Apparent concentration trends in space and time can easily be falsely attributed to biodegradation, when none is occurring. Moreover, interpretation of compound-specific isotope signatures, commonly thought to provide unequivocal evidence of biodegradation, can lead to similar misinterpretations when the physical transport processes are neglected. For example, modeling the transport of heavy and light carbon isotope versions of methyl *t*-butyl ether, (MTBE) $CH_3OC(CH_3)_3$ ($^{13}CH_3O$ D*, heavy *vs.* $^{12}CH_3O$ D, light) due to groundwater movement and diffusion (Brownian motion) shows that either aerobic biodegradation or diffusion processes can produce the same isotopic signature that has been attributed to biodegradation. Consequently, field data used for assessing natural attenuation of contaminants can be interpreted with greater reliability.



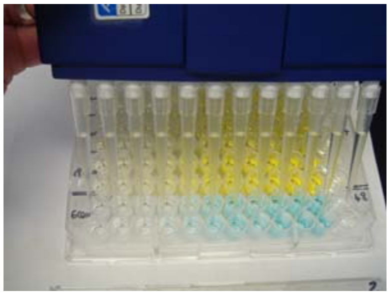
Impact

The research has provided a firmer scientific basis for both predicting fate and transport of groundwater contaminants and for assessing their long-term persistence. Interestingly, the methods of modeling groundwater contaminant transport cross over into biological applications in medicine and plant physiology where relatively fast fluid transport occurs together with slow, diffusive transport in vascular systems. Potential extension of the groundwater modeling methodology to other disciplines beyond groundwater science highlights the basic contribution of this work.

Rapid evaluation of toxicants: "Toxicology in the Fast Lane"

Background

For decades, the assessment of toxicity of chemicals uses laboratory animals. Data on acute and chronic toxicity, reproductive effects, and cancer are developed from studies using large numbers of animals.



These studies are very costly. Routinely the data are used for human or environmental health risk assessment. In rare cases, is detailed information generated about the site where toxic effects actually occur. Follow up studies involving organs or specific tissues that contain receptors or enzymes often provide more precise information about a chemical's effect on a target. Researchers at UC Davis developed a battery of tests that could be used before whole-animal studies are initiated thus reducing the number of animals utilized. These evaluations are run efficiently in 96-well plates shown in the figure on the left. This type of assessment is termed High Throughput Screening (HTS). Nine enzymes and six receptor-based assays were used in the evaluation of 176 chemicals selected from classes of chemicals known to have biological activity on receptors or enzymes. Representative structures from pesticides (insecticides, herbicides, antimicrobials, fungicides), flame retardants, and a plastic monomer were tested in this process. The HTS evaluation of recognized biologically active structures provides the necessary validation set for future testing of additional chemical structures. The experimental methodology used to define the interaction of triclosan (highlighted above) with heart-derived receptors was easily incorporated into the HTS process,

Impact

The miniaturization of toxicology evaluations into HTS generates mode of action information rapidly. Prospectively, these data can be used for new industrial chemicals planned for commercial introduction or retrospectively for chemicals already in commerce when new concerns emerge about their effects related to the occurrence in humans or other environmental compartments. Over time the HTS process and data must be correlated with effects that occur in whole animals to refine its predictive potential. Once these correlations are strengthened, it may be possible to reduce the number of animals used for the development of human and environmental risk assessments.

Since this newsletter is still in its formative stages, we welcome critique so future Research Updates will be improved and hopefully better meet the interests and needs of the recipients. We would like comment on content, communication effectiveness and whether these updates might foster interactions and relationships with others outside the UC Davis Superfund Research Program. Finally, please share this Research Update with your colleagues who may have an interest in the results of our research.

For more information about the UC Davis SRP, contact: James R. Sanborn, Research Translation Coordinator, JRSanborn@ucdavis.edu or (530) 752-8465.