Troubled waters: New device brings flexibility, precision to contamination measurement

November 8 2011

Lake Apopka—Florida's third largest—was once a haven for migratory birds, vacationers and fishermen. Today it is a toxic broth of chemicals and ranks among America's more disturbing Superfund sites.

Here, Rolf Halden and his colleagues from the Biodesign Institute at Arizona State Universityand collaborator Nancy Denslow at the University of Florida, Gainesville, are testing a new device, designed to measure contaminants with unprecedented precision, accuracy and sensitivity. In addition to detailed analyses of sediments, the team will evaluate the health effects of five specific compounds on two species of marine organism. The new project will also assess the effectiveness of remediation efforts currently being used to clean up the contaminated site.

Halden, associate director of the Swette Center for Environmental Biotechnology and his team have recently received a three-year, $830K grant from the National Institute of Environmental Health Sciences (NIEHS). Their efforts are expected to provide stakeholders at many of the nation's Superfund sites with a novel analytical tool to gauge the threat to public health posed by contaminated sediments before, during and after cleanup efforts.

The instrument being used for these studies is known as the in situ sampling/bioavailability determination tool or IS2B—a patent-pending

device that can simultaneously measure contaminant levels in bulk water and pore water (the fluid occupying spaces between sediment particles).

Halden says that conceptually the sampling instrument is simple, but emphasizes that IS2B nevertheless will facilitate analyses with uncanny resolution: "Once perfected, the device will enable the determination of the fraction of chemicals that actually are available for uptake by aquatic organisms; this knowledge is important because it determines the body burden in, for example, fish harvested for human consumption."

When IS2B is in use, half of its tubular body lies buried in sediment while the other is exposed to bulk water. Integrated multi-channel pumps draw bulk water and sediment pore water into the active sampling device and push it through an array of filters and adsorption media at, respectively, high and low flow rates.

The innovative design of IS2B allows a broad spectrum of contaminants—some occurring at minute levels—to be detected and accurately measured. These include fully water-soluble to highly sorptive and hydrophobic chemicals, giving the apparatus considerable versatility compared with presently available passive sampling technologies.

According to Halden, previous modeling efforts indicate that the IS2B is capable of sampling bulk and pore water pollutants at sub-nanogram per liter levels. Further, the device will permit measurement of bioavailability (how much of a chemical is present and able to cross an organism's cellular membrane) and bioactivity (a chemical's effect on living matter).

The project underway at Lake Apopka focuses on two traditional and three emerging sediment contaminants (p,p'-DDE and dieldrin; and fipronil, triclosan and triclocarban). The lake became contaminated with these and other chemical toxins as a result of a series of environmental

mishaps, including a large spill in 1980 by the Tower Chemical Company, which had been producing dicofol, a mixture of the pesticide DDT and DDE—one of DDT's breakdown products.

Both DDT and DDE are reproductive toxicants for a variety of bird species, and are linked with the decline of the bald eagle, brown pelican, peregrine falcon, and osprey. Dieldrin is a chlorinated hydrocarbon pesticide, originally developed as an alternative to DDT. It has been found, however, to stubbornly resist breakdown, remaining in the environment as a persistent organic pollutant. Fipronil is a slow-acting pesticide, while triclosan and triclocarbon are both antibacterial/antifungal agents.

Shortly after the accident, 90 percent of the lake's alligators disappeared. Large numbers of migratory birds were poisoned, likely from consumption of contaminated fish. Further, migrant farm workers engaged in citrus cultivation in the area lost their livelihoods when area farms were shut down. Many were subsequently beset by a variety of health issues, believed to be related to the contamination.

Superfund sites are those belonging to the Comprehensive Environmental Response, Contamination and Liability Act (or "Superfund" law). The Environmental Protection Agency compiles a database of such sites, which are deemed to pose a risk to human health and/or the environment. While over 40,000 such sites exist in the U.S., only a fraction of these have been placed on the National Priorities List (NPL) and targeted for cleanup.

The five contaminants in the new study will be evaluated for their effects on two marine organisms— Lumbriculus variegates, (a species of black worm) and Pimephales promelas (known as the fathead minnow). Contaminant exposure in fish will also be examined using DNA microarray analysis, allowing for a determination of health effects that

may not be predicted solely on the basis of exposure levels to parent compounds.

Both theory and laboratory data will be used to establish mathematical relationships between pollutant concentrations in bulk water, pore water, worms and fish. These results will then be applied to IS2B-derived data to predict existing health risks. Further, the study will monitor the effectiveness of two remediation approaches, granular activated carbon (GAC) amendment and deep tilling of contaminated sediment.

Halden is optimistic about the potential of the new project to accurately measure contaminants, evaluate their risks to health, and ultimately inform policy to avert potential human exposures and associated adverse health outcomes: "The project will provide information on traditional and so-called emerging contaminants, whose unintended health risks are just now becoming apparent as chemicals production is still ramping up."

Provided by Arizona State University

Citation: Troubled waters: New device brings flexibility, precision to contamination measurement (2011, November 8) retrieved 22 September 2024 from https://phys.org/news/2011-11-device-flexibility-precision-contamination.html