Wastewater treatment offers a view into environmental chemicals' risks

By Carol Kelly

Wastewater treatment facilities offer tremendous value as observatories for what chemicals are being produced, consumed, and circulated in our environment, according to new research *(http://www.ncbi.nlm.nih.gov/pubmed/24429544)* from NIEHS grantees Arjun Venkatesan, Ph.D., and Rolf Halden, Ph.D., from Arizona State University (ASU).

"Our study highlights the use of sewage treatment plants as a resource, instead of treating them as a mere decontamination factory," said Venkatesan, a doctoral research associate in Halden's lab *(http://labs.biodesign.asu.edu/halden)* at ASU.

Wastewater treatment facilities are the cornerstone effort to keep the nation's waters clean. Processed solid waste material is a residual of wastewater treatment, and the byproducts labeled biosolids are characterized as treated, tested, and determined safe for land application. These biosolids contain nutrients useful as fertilizers, as well as heavy metals, toxicants, and pathogens.

Rolf Halden, Ph.D., is director of the Biodesign Institute Center for Environmental Security; professor in the School of Sustainable Engineering and the Built Environment; and senior sustainability scientist at the Global Institute of Sustainability at ASU. (Photo courtesy of Arizona State University)

Testing biosolids

The researchers analyzed biosolids from municipal wastewater treatment plants to identify contaminants of emerging concern (CECs), which are chemicals known to be harmful, but with unknown risk from their presence, frequency of occurrence, or source. Of particular interest to the researchers were chemicals that stay intact during their journey through several phases of wastewater treatment to the biosolids stage. It was important to identify these chemicals, because they are likely to also persist in the environment. Using a nationally representative sample of biosolids collected by the U.S. Environmental Protection Agency (EPA), the researchers detected 123 CECs. The quantities of those chemicals found in the samples can be used to estimate the amount of each originally produced.

"Our study sends a powerful message that the chlorinated, brominated, and fluorinated chemical compounds mass produced today do not biodegrade safely or naturally," said Halden. "We provide a way to identify toxic priority compounds used daily in large quantities that are prone to accumulation in organisms and people."

Arjun Venkatesan, Ph.D., is currently working on monitoring the occurrence and persistence of emerging contaminants in biosolids, soils, and sediments at ASU. (Photo courtesy of Arizona State University)

Monitoring contaminants

Common chemical screening methods typically do not consider two important risks to people and ecosystems - current chemical production rates and how chemicals behave in real-world biological systems. The researchers believe that their approach, using biosolids to identify amounts and types of chemicals present in the environment, addresses these shortcomings, and should be a welcome addition to the toolbox for risk assessors tasked with prioritizing and managing CECs.

"One could better understand, or even predict, the fate and distribution of mass-produced chemicals in environmental systems, by studying the amount and behavior of those chemicals in sewage treatment plants," said Venkatesan.

"In addition to monitoring compounds as produced, biosolids can provide estimates of the identity and volume of chemical transformation products resulting from their degradation," said Halden. "This chemical progeny may be equally, or more, harmful than their parent compounds. One example is nonylphenol, an endocrine disruptor, which is released from the breakdown of alkylphenol ethoxylate detergents."

Assessing biosolids risk

In the U.S., more than 50 percent of biosolids produced by wastewater treatment are applied to land as an agricultural

amendment, according to the EPA. To reduce the amount that must be landfilled or incinerated, they are increasingly used as soil conditioners or fertilizers, or for land reclamation. Various land applications of biosolids take place in all 50 states.

In 2002, the National Research Council said that EPA should conduct studies of the potential health risks, or lack thereof, to workers and residential populations exposed to biosolids from land applications, but this recommendation has not been addressed to date. EPA regulations require periodic monitoring of certain heavy metals and indicator bacteria in solid waste from wastewater treatment, but there is no routine monitoring of other toxicants. The finding of CECs in the study's biosolids samples underscores the need for improved assessments, according to the researchers.

"We need to take steps now to avoid human and ecological health hazards, as well as the costly, long-term contamination of soil and water resources nationwide," said Halden. "The return on investment can be huge. It's much more expensive to clean up or treat large-scale environmental contamination than to treat comparatively smaller process streams at the source."

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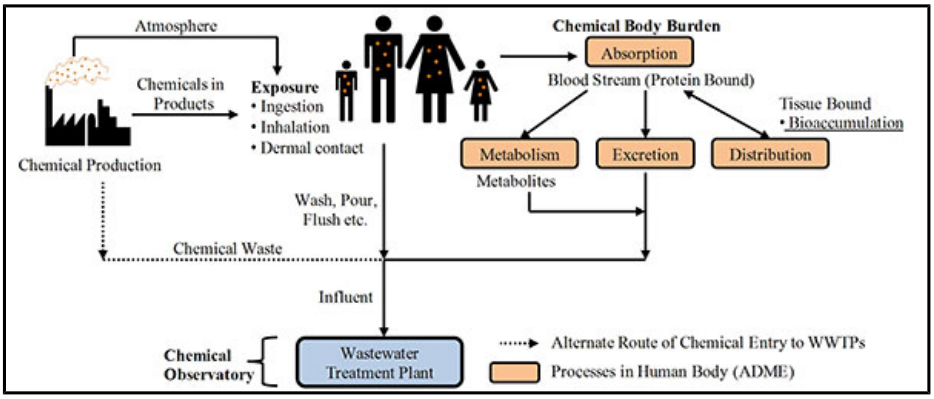

The researchers' diagram shows how chemicals move from production, then into and through people, to the wastewater treatment environment. (Photo courtesy of Arizona State University)

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