
CHARLES SANCHEZ

Evaluating Contaminants in Colorado River Water

Lead and uranium levels are focus of study

By Susan McGinley

Along its 1,450 mile run from northern Colorado to near the Gulf of Mexico, the Colorado River accumulates low levels of potentially toxic heavy metals, including uranium (U) and lead (Pb). Although these levels fall below established safety thresholds for human consumption, little information has been available on the sources of these metals, or how much they contribute to soil and crops irrigated with water diverted from the river.

An estimated 20 million people use the Colorado River as their drinking water source, and millions across the nation and the world eat the fresh produce grown in the Lower Colorado River Region. Fresh-market produce from the area is worth about $2 billion annually.

With support from Arizona's Technology Research Initiative Fund (TRIF) and others, two University of Arizona scientists have led a multi-institutional effort to collect and analyze water samples from the Colorado River for heavy metal content, and to test the tissues of fruits and vegetables grown in the Yuma, Imperial and Coachella valleys. Their comprehensive testing offers reassurance that, so far, the water and the produce are safe to consume from a heavy metal standpoint.

Principal investigators Charles Sanchez, a professor in the UA Department of Soil, Water and Environmental Science, and John Chesley, research scientist in the UA Department of Geosciences, took water samples from the entire length of the Colorado River and its main tributaries in 2007, 2008 and 2009. Cooperators on the project included Yemane Asmerom, University of New Mexico; Daniel Malmon, US Geological Survey, California; and R.I. Krieger, University of California, Riverside.

"We wanted to know if the levels of uranium and lead in the river were problematic as food chain transfer and in drinking water," says Sanchez, who directs the UA Yuma Agricultural Center. "We also wanted to find out if the sources of uranium and lead were natural or anthropogenic—resulting from human activity." In sufficient amounts, both metals are potentially carcinogenic and can seriously disrupt human organ function.

The team's baseline analysis of heavy metals in the 2007 and 2008 samples showed uranium concentrations increasing progressively downstream, from less than 0.05 parts per billion (ppb) at the headwaters near Grand Lake in northern Colorado to values greater than 3 ppb after descending onto the Colorado Plateau, according to the researchers' report. In the lower basin, water diverted for municipal and irrigation use had uranium concentrations of 3 to 5 ppb. (Samples from 2009 will be analyzed when further funding is obtained.)

Other metals (cadmium, arsenic, manganese, etc.) were present, but all were below the maximum thresholds set by the Environmental Protection Agency for national drinking water standards.

In particular, the scientists sought to gain a better understanding of uranium concentrations and sources along the river because the current search for alternative energy sources has revived an interest in uranium mining on the Colorado Plateau, which is drained by the Colorado River.

"We need to collect baseline data against future changes that may occur in heavy metal levels in the river," Sanchez says. "Ideally, we would like a five-year database if we could keep the project funded that long."

To find out whether uranium and lead in the samples came from mining activity or from other sources, Sanchez and Chesley used ratio isotopes of lead (208Pb, 207Pb, 206Pb and 204Pb) in water samples to "fingerprint" the sources of uranium, lead, and by proxy other metals found in the Colorado River. These isotopic ratios vary as a function of natural radioactive decay. They can be used to separate out original sources of contamination because the various sources have characteristic ratios that can be tracked through the weathering downstream along the course of the river.

"Only mixing of different sources will change these ratios," says Chesley, who is co-director of the Arizona Laboratory for Emerging Contaminants, located on the UA campus. According to Sanchez' and Chesley's report: "Isotopes of uranium can show you if a sample is from a naturally occurring location where weathering has occurred, or if it's from uranium mines. Our data for uranium in the river show it is generally from natural weathering processes from the geomedia [rocks and soil] within the basin, and not from previous mine tailings or mining activity."

Lead and uranium concentrations can increase through natural weathering, through drought, or through a combination of both. For example Sanchez and Chesley note that lead or uranium-containing runoff and dust can develop from abandoned mines and also from desiccated deposits of natural sediments.

In addition, lead, which is a natural byproduct of decaying uranium, can also accumulate in agricultural soils as a result of

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The Arizona Laboratory for Emerging Contaminants assists faculty, student and staff researchers at the UA, Arizona State University, Northern Arizona University—and other researchers working in the field of water sustainability—in detecting and quantifying organic and inorganic micro-pollutants.

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phosphorus fertilizer applications. Between 2007 and 2009, Chesley and Sanchez conducted a series of tests on irrigation water, soil extracts and crop plant tissues to find out if that was the case in the Lower Colorado River Region, and to determine whether the lead and uranium were deposited in fruits and vegetables irrigated with water from the river. Funding for this work was provided by the Arizona Iceberg Lettuce Research Council, the Arizona Grain Research and Promotion Council and the USDA Specialty Crop Block Grants Program.

These studies show that although most uranium and lead in crops is from the river water and sediments rather than phosphorus fertilizer, they are well below levels of concern.

"For the vegetables produced with Colorado River water we calculated the daily uranium dosage from lettuce, carrots, oranges, lemons and other crops," Sanchez says. "The findings indicate that levels were far below the World Health Organization Reference Dosages (RfD) of uranium for human consumption. Even if all of your produce intake came from Yuma, you'd still get less than one percent the RfD for exposure to uranium. It's not even close to being a health issue."

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Soils tested were from spots that had been farmed and continuously sampled over a 35-year period along the lower Colorado. Although irrigation water and phosphorus fertilizers were both potential contributors of uranium and lead to agricultural soils in the area, analyses revealed that lead remained bound in the soil and was not transferred to the plant tissues sampled. The team reported they could "detect no increase in plant available soil, U or Pb after 35 years of irrigation and fertilization."

"Contaminants can come from any point along the river," Chesley adds. "If you look at a leaf of lettuce, it's the sum of all the solutes you put on it, the metals that are naturally occurring in the soil and what's contained in fertilizer and water. Growers want to make sure they're below the limits set in food by the USDA and the European Union."

As a next step, Chesley and Sanchez would like to use fish as natural samplers of bioavailable metals at various sites in the Colorado River.

"Fish are natural integrative samplers—they can concentrate heavy metals in their livers," Chesley says. "We can look at what they're eating and the water they are living in and determine whether we should be concerned about downstream effects on human health."

"We also want to show the Arizona Department of Environmental Quality and the EPA which heavy metal sources are more bioavailable, as a way to help agencies target where their cleanup monies are going and to better serve the public in terms of policy decisions and the best use of resources." ❂

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