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San Luis Valley Water Quality Report

Uranium

PREPARED BY: NICHOLAS STOLL
NAOMI PERLMAN
LUIS LOPEZ
KATHERINE A. JAMES

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WHAT IS URANIUM?

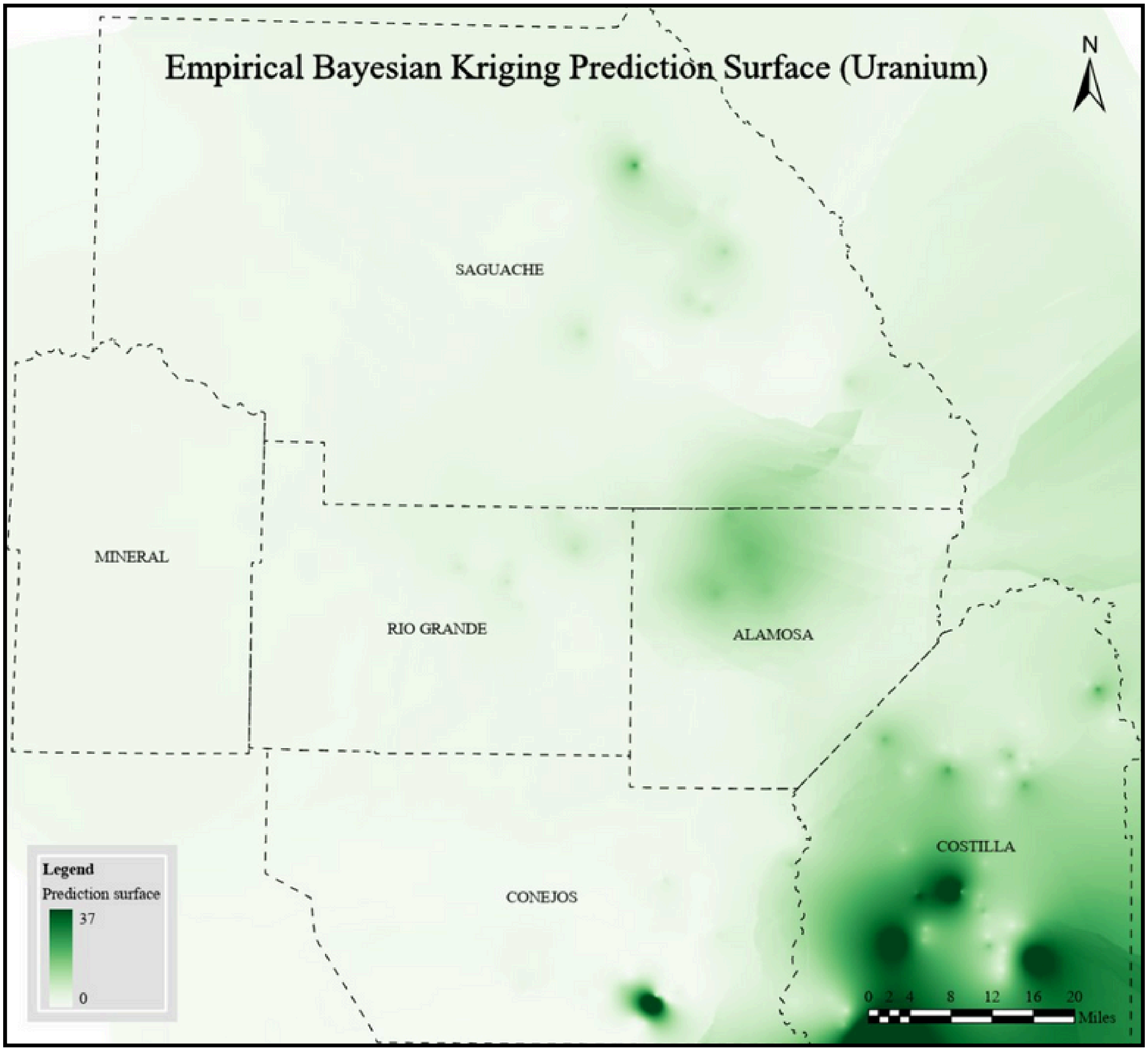
Uranium is a naturally occurring radioactive heavy metal and is one of the more common elements found in the Earth's crust (more common than gold), with trace amounts present in almost all soil, rock, and water. This metal is silvery-white, malleable, and very dense. It is almost impossible to tell if uranium is present in food, water, or air without laboratory analysis.

There are three main uranium isotopes: U-238, U-235, and U-234. Of these isotopes, U-238 composes over 99% of the naturally occurring uranium and is much less radioactive than it's counterparts. U-234 composes less than 1% of naturally occurring uranium and is the source of almost half of all uranium radioactivity. While U-235 *can* occur naturally (occurs less than U-234), it is primarily derived from human activities. This is the isotope used in nuclear reactors and weapons.

The presence of uranium in the San Luis Valley (SLV) is likely due to the region's geologic formation along the continental divide and historic volcanic activity. However, human activities can also introduce uranium to the environment. Mining can expose uranium deposits to the elements, allowing it to infiltrate water resources or be displaced by the wind.

The threat of uranium on human health is two-fold as it has implications from biologic toxicity and radiation. The general population is most likely to be exposed to trace amounts of uranium through food and drinking water. People living near uranium mining sites, facilities generating nuclear power, or facilities developing or testing nuclear weapons may have increased exposure.

While the general U.S. population may experience minimal or no exposure from drinking water, Phase I of our community-wide sampling of privately-owned groundwater wells suggests some parts of the SLV may have elevated levels of uranium in drinking water. Of the samples we collected, 97.7% of samples contained a measurable level of uranium. Current government regulations only regulate public and municipal drinking water (30 ug/L). There are no established programs for addressing contaminated drinking water for private well owners. Approximately 2% of samples contained uranium over the 30 ug/L threshold and only 11.2% of samples over 5 ug/L.



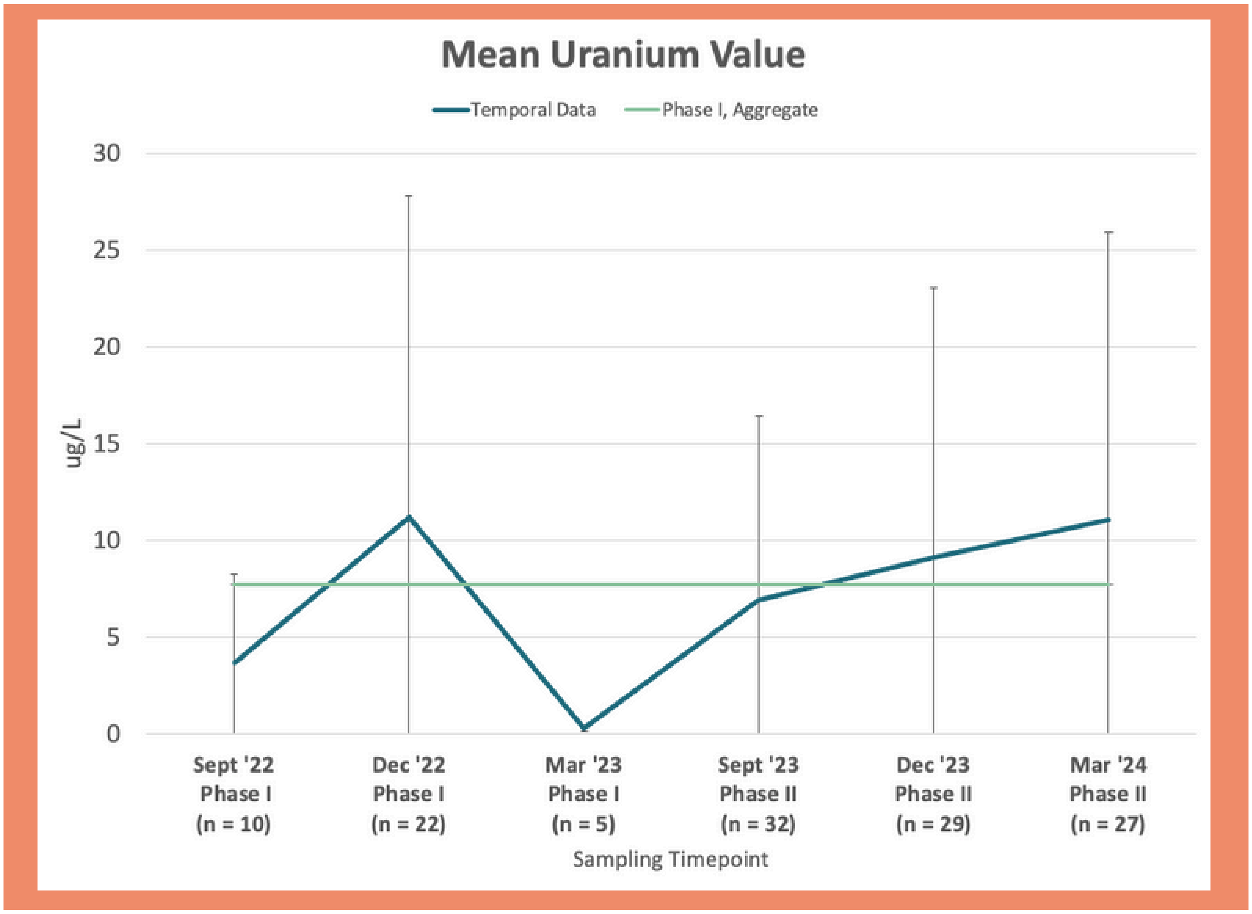
Prepared by Guiye Li and Dr. Geofeng Cao at the Department of Geography at the University of Colorado, Boulder.

University of Colorado Boulder

CONCENTRATION MAP

Using data collected in Phase I of the study, we've created a map to show the distribution of uranium concentrations across the San Luis Valley. Please note, uranium concentrations are likely influenced by well depth, surrounding soil/minerals, and other complex geologic factors

This map was created using Empirical Bayesian Kriging (EBK) methods. EBK is a modeling technique that uses prior collected data to predict a range of values at locations without any sampling sites. It allows us to estimate metal concentrations more accurately while accounting for a level of uncertainty.



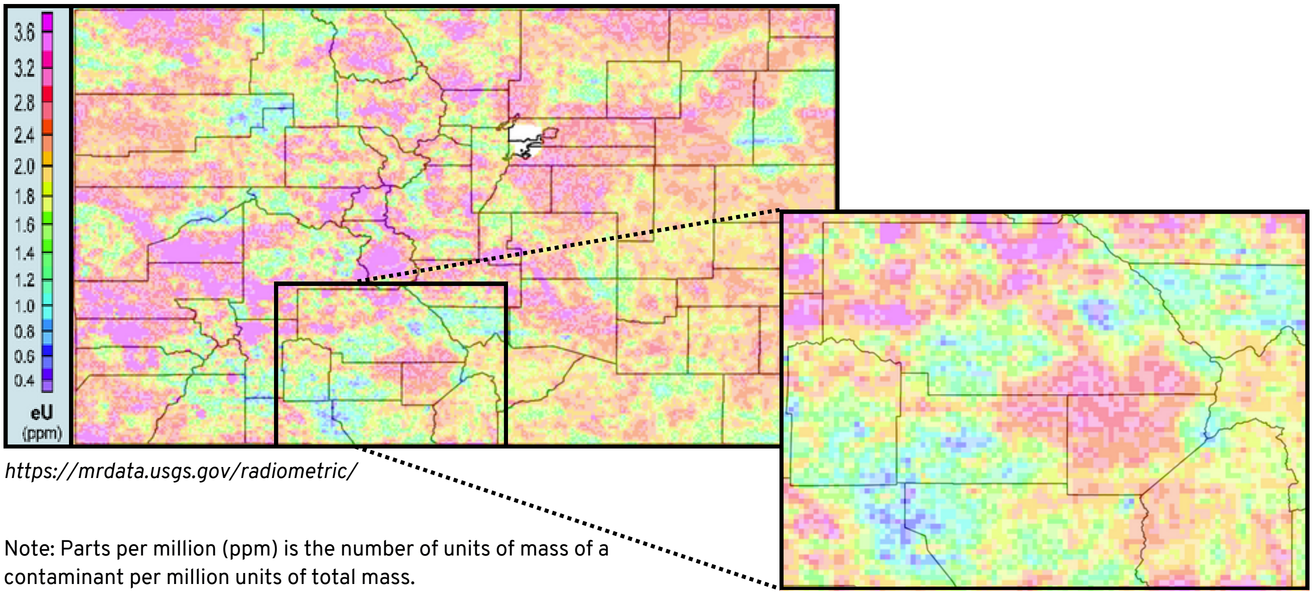
TEMPORAL MODELING

As part of our current project, we're investigating how the levels of different metals in groundwater vary across the San Luis Valley region and over time. By analyzing samples from the community and information from well permits publicly maintained by the Division of Water Resources, our partners at Colorado State University and Stanford University have helped to create spatial and temporal models.

In the graph above, we've displayed preliminary results for the fluctuation of uranium over time. These results are based on the roughly 45 community members participating in the Phase II repeated sampling. Phase I timepoints were created using Phase I samples from Phase II participants. The green reference line indicates the mean level of uranium for all Phase II participants across the Phase I timeframe.

Please note, these results are limited in their generalizability due to the uneven distribution of Phase I samples across these pseudo timepoints and may not accurately represent how water quality changes with time. Our understanding of this relationship is likely to change as we collect more data.

On the next page, we include a spatial model for the presence of uranium in groundwater across the SLV.



https://mrdata.usgs.gov/radiometric/

Note: Parts per million (ppm) is the number of units of mass of a contaminant per million units of total mass.

ESTIMATES ON DISTRIBUTION

The United States Geologic Service (USGS) plays an active role in monitoring and managing natural resources. It has facilitated multiple assessments on the contaminants of groundwater resources and the composition of the soil in the United States. The map above utilizes information collected by USGS from 1999 through 2005 to estimate the terrestrial distribution of Uranium using gamma-ray surveys. According to the USGS, "aerial gamma-ray surveys measure the gamma-ray flux produced by the radioactive decay of the naturally occurring Uranium-238 in the top few centimeters of rock or soil. If the gamma-ray system is properly calibrated the data can be expressed in terms of the estimated concentration of Uranium-238. This ternary color-composite image was generated by commercial software Geosoft Oasis Montaj to map the composition of Uranium-238."

At this time, our team believes this model to be the best existing resource available for comparing the results from our current study on groundwater quality. While this model focused on soil and rock composition versus groundwater, these element mediums are also known to heavily influence the presence of uranium in groundwater. However, we would also like to note the model's limited generalizability to the local setting. Surveys of this magnitude and scale are hard-pressed to create models with high specificity to the local context. Additionally, there are notable magnetic anomalies within the San Luis Valley which may be influencing data collected from aerial radiometric devices.

Following sections in this report will cover information on health effects and possible interventions.

EXPOSURES AND HEALTH EFFECTS

Within the context of the San Luis Valley (SLV) communities and environmental health, ingestion is the primary mode of uranium exposure. Inhalation exposure is of concern for certain occupations, but not in the typical community setting. In any circumstances where your level of exposure is of concern, we recommend consulting with your primary care provider.

The toxicologic health effects of uranium are largely dependent on the specific uranium compound for which a person is exposed. Uranium on its own is not very soluble and more difficult for the body to absorb. Uranium compounds composed of more soluble elements are more likely to be absorbed. Toxicologists estimate our body absorbs the following percent of the total uranium experienced per mode of exposure.

0.1-6% Ingestion
0.76-5% Inhalation

Once absorbed, uranium is likely to be stored in your bones, liver, and kidneys. An estimated sixty-six percent of absorbed uranium can be found in your bones.

Because of the distribution of absorbed uranium, existing data and research cite toxicologic health effects related to renal and pulmonary damage (due to biologic toxicity). Unfortunately, there is not enough research to determine a dose-effect relationship for this exposure. Research in animal trials have found some evidence of long-term neurobehavioral changes, decreased fertility, and skin irritation - but, there is not yet enough evidence to generalize these effects to humans.

Due to uranium's radioactive aspects, the localization of the element to human bones, liver,

https://mytapscore.com/blogs/tips-for-taps/uranium-contamination-drinking-water

and kidneys may contribute to the development of cancer. Uranium is not directly linked to lung cancer. However, the element slowly undergoes radioactive decay to become radium. Radium then decay's into radon, which *has* been associated with lung cancer. The time it takes for radium to decay is dependent on its specific isotope form.

INTERVENTIONS

Identifying a health risk is the first step in promoting public health. If you're being exposed to uranium and want to take precautions, what's next?

CUMULATIVE EXPOSURES

Understanding where your exposure originates is important. While this report describes the health effects of uranium, specifically, the cumulative impact of environmental exposures is a more influential driver of health. This is true for both radiation and toxicologic exposures. Reducing your cumulative exposure - or your total exposure, is beneficial for overall health.

Since we know the primary route of exposure for uranium in the community setting is ingestion, we can readily identify specific actions to reduce consumption through food and water.

EXPOSURES AND INTERVENTIONS

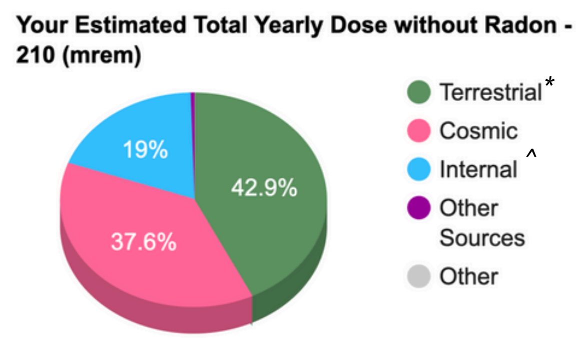
Root crops such as potatoes, parsnips, turnips, and sweet potatoes contribute to the highest amounts of uranium to our diet. Since the element is relatively insoluble, thoroughly washing these produce items should help eliminate uranium from the nearby soil. The amount of uranium in these foods is directly associated with the soil in which they are grown. Consider discarding the outer portion of root crops grown in soil with known uranium contamination.

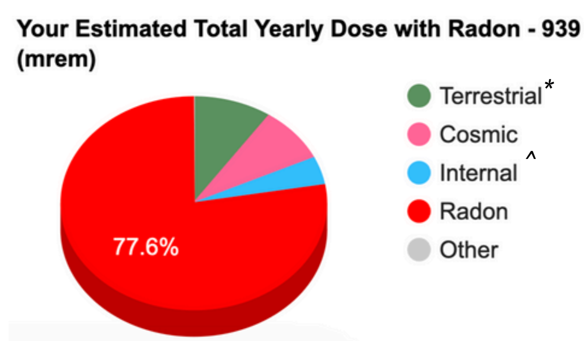
Similarly, the amount of uranium contained in drinking water is directly associated with its source environment. Groundwater wells that neighbor deposits of uranium are likely to measure higher levels. Uranium can be removed from drinking water with various types of filters. Reverse osmosis filters are commonly used and can remove 95-98% of uranium from drinking water.

RADIATION

We are exposed to radiation in our everyday lives as it originates from many sources. Background radiation (radiation from the earth's crust and cosmic rays hitting atoms in the atmosphere) are not considered exceptionally harmful for the typical person due to their low dose range. Radiation from radon and medical radiation are much larger contributors to the average person's annual dose of radiation.

Below are radiation exposure estimates for the San Luis Valley calculated using the EPA's radiation calculator (estimates calculated for non-smokers without recent medical radiation exposures).





https://www.epa.gov/radiation/calculate-your-radiation-dose

*From the earth's crust
^From food and water

INFORMATION SOURCES

Where did we get this information?

Results and modeling in this report were created using the data collected from this research project. Specific questions about this data can be directed to Dr. James (Kathy.James@cuanschutz.edu).

Information on the human health effects of uranium exposure, presence of uranium in groundwater, and intervention strategies for mitigating uranium exposure were aggregated from the following sources. Please note, the information presented was tailored to the contextual factors of the San Luis Valley. This report is not an exhaustive summary of research on uranium exposure.

ATSDR Agency for Toxic Substances and Disease Registry

CDC Centers for Disease Control and Prevention
CDC 24/7: Saving Lives, Protecting People™

EPA United States Environmental Protection Agency

NIH National Institutes of Health
Turning Discovery Into Health

USGS
science for a changing world

World Health Organization