Gardening: Connecting Mother Earth to Human Health and Wellness

COLLEGE OF PHARMACY
METAL EXPOSURE AND TOXICITY ASSESSMENT ON TRIBAL LANDS IN THE SOUTHWEST

UNM METALS Superfund Research Center

Metal Exposure and Toxicity Assessment on tribal Lands in the Southwest

UNM METALS SRP Report-back to Village of Old Laguna on Soil, Plant and Water Testing

Pueblo of Laguna
October 6, 2022

Presenters:
Derek Capitan, Kyle Swimmer, Chris Shuey, Adrian Brearley

Presentation developed by
Derek Capitan, Eliane El Hayek

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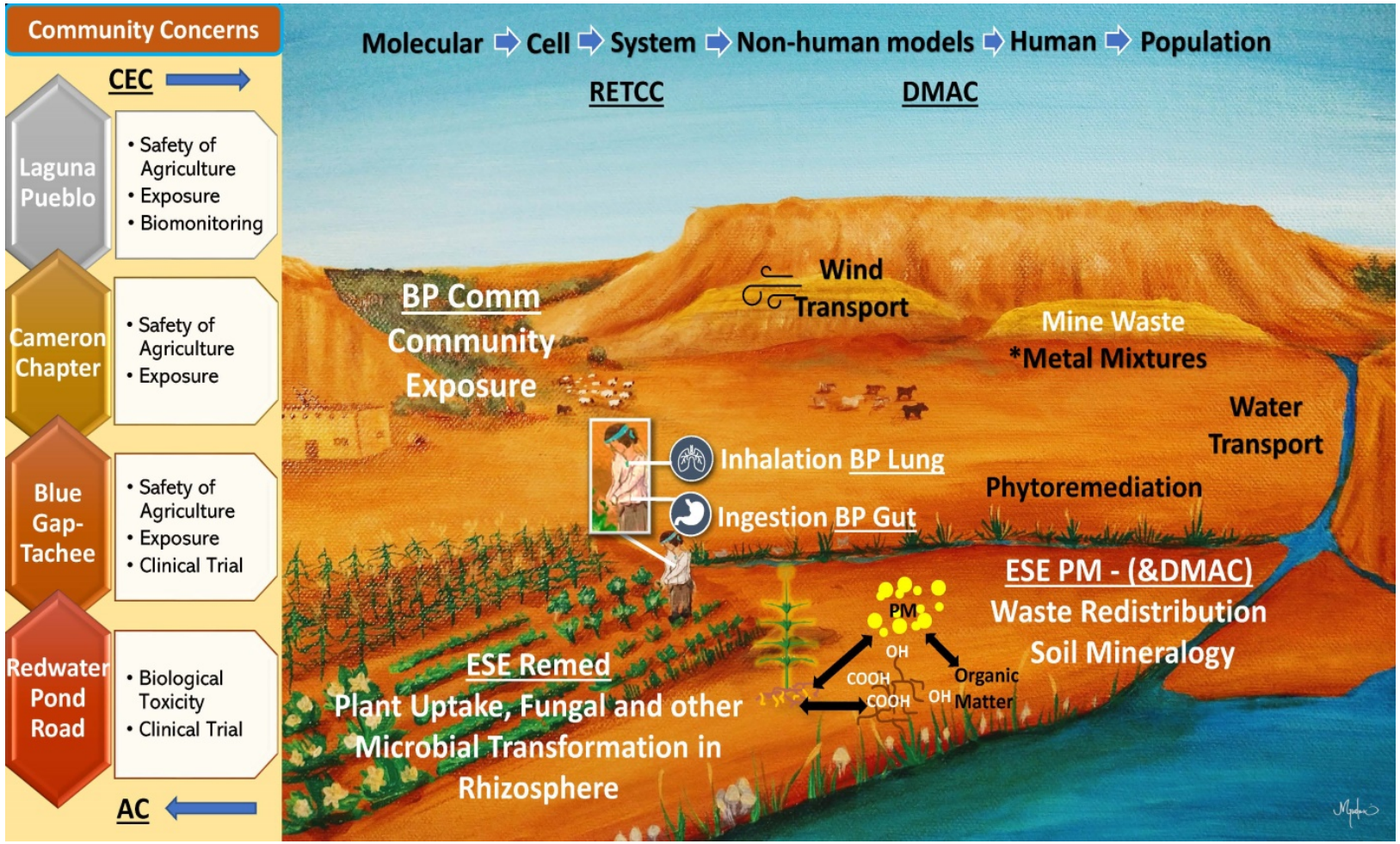
METALS SRP: From the Land to the Cell…and Back Again

UNM METALS works with the community to understand and reduce health risks

Four Indigenous communities affected by uranium mining legacy



Original artwork by Mallery Quetawki (Zuni)

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Acknowledgements

Guuwaadzi – UNM's work evidences the importance of developing community-driven research to work together and bring scientists, gardeners and farmers as a team to answer community concerns and investigate mining legacy.

We acknowledge that through the trial and tribulation we continue to stand strong. For it's the rest of our story that will make us who we are and who we chose to be.

Our key for the future: Blending traditional practices with modern day technology.

Special acknowledgement– Leadership and staff of the ***Laguna Environmental and Natural Resources Department*** for their partnership, support and oversight.

UNM Acknowledgement Statement: *The University of New Mexico sits on the traditional homelands of the Pueblo of Sandia. The original peoples of New Mexico have deep connections to the land and have made significant contributions to the broader community statewide. We honor the land itself and those who remain stewards of this land and acknowledge our committed relationship to Indigenous peoples.*

Objective

- ***Inform the community about metals levels in soils and crops, particularly corn and vegetables (squash, pumpkin, cucumber, melon)***

Main Message

- ***Metals levels in soils at the investigated farming sites are consistent with natural background, and do not indicate impacts of uranium mine wastes***
- ***Tested fruiting vegetables are safe to eat***

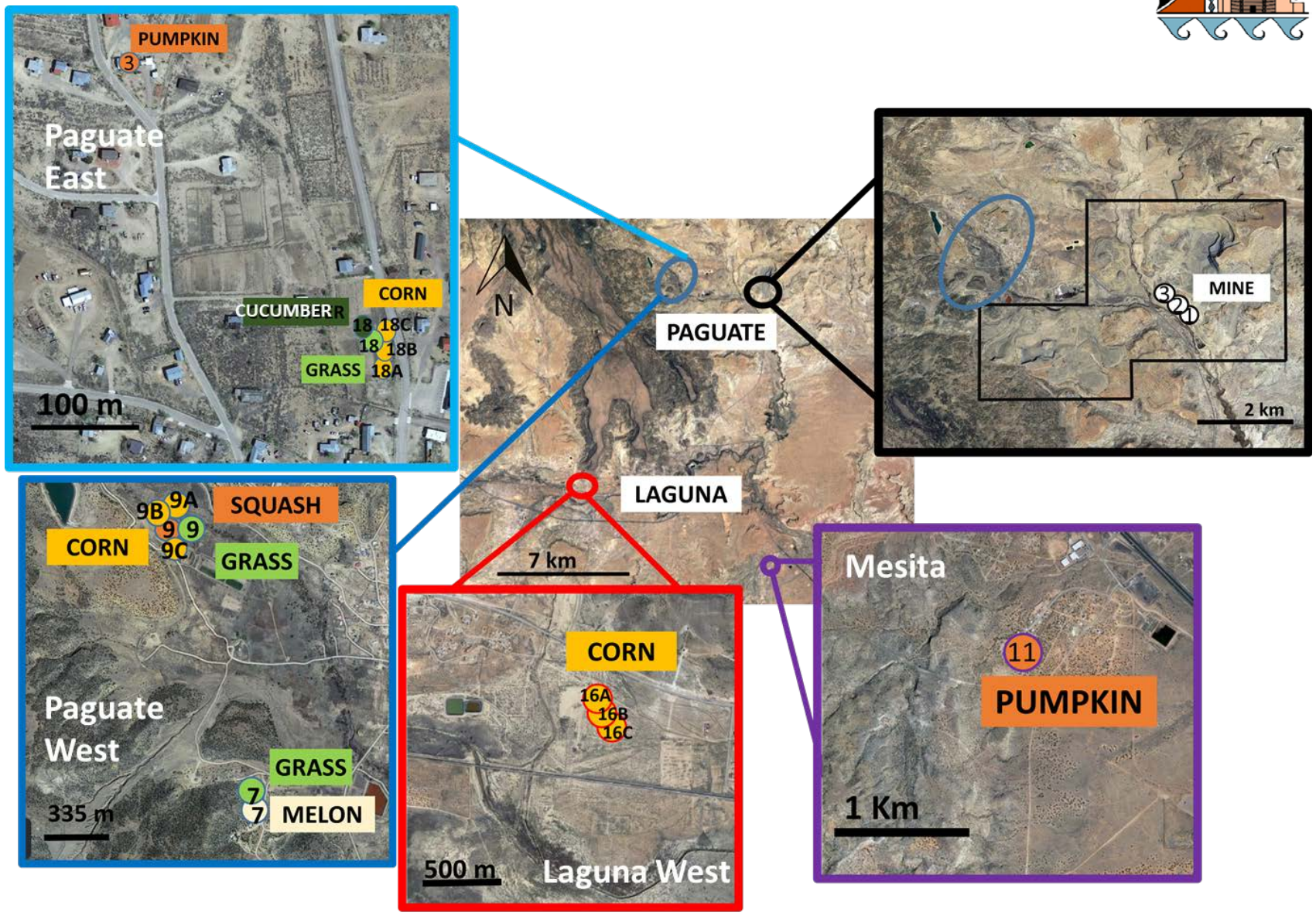
Methods: About soil and plant sampling sites

- Surface access agreements executed with 21 families
- Sampling sites: Paguate (17), New Laguna (4), Mesita (1)
- Sampling locations selected based on
  - Agreements with growers who volunteered for the program
  - Geographic distribution, proximity to Jackpile Mine
  - No previous soil or plant-metals data

  (sites were not pre-screened)
- Crops: corn from 3 sites, fruiting vegetables from 5 sites
- Surface soils (12”-inch depths) from three sites inside the Jackpile Mine ~ 3 km away from Paguate village

*Locations of soil and plant sampling sites**

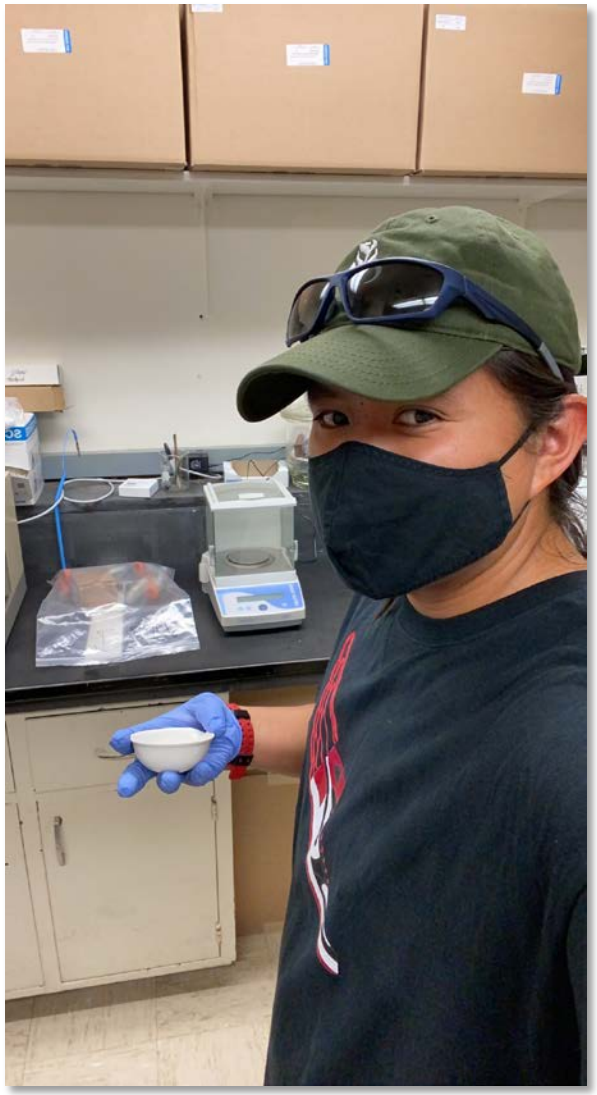
Site No.	Village	Samples
3 (garden)	Paguate	soil, pumpkin
7 (garden)	Paguate	soil, melon, grasses
9 (farm)	Paguate	soil, corn, squash, grasses
11 (garden)	Mesita	soil, pumpkin
16 (farm)	Laguna	soil, corn
18 (garden)	Paguate	Soil, corn, cucumber, grasses
Jackpile Mine	Paguate	Soil, grasses, roots



*Not all sampling sites shown on these maps

Methods of Analysis

1. Drying of soils
2. Sieving into different size fractions (grinding of sample)
3. Digestion in acid (Getting sample into its purest form)
4. Followed by analyses using ICP-MS* technology (data interpreter)



Derek Capitan processed many Laguna soil and plant samples at the UNM lab

*ICP-MS = Inductively coupled plasma mass spectrometry

Units (Measurements) used for DATA

- Levels of metals in crops or soil –

“parts per million” or “ppm”
(diagram)

- 1 ppm means that for every million “parts” of dry soil, there is 1 part of the metal being measured
- 1 ppm = 1 milligram of element in 1 kilogram of dry soil, or “mg/kg-dry wgt”

Units of measure for metals in water or sediment:
1 milligram per liter (mg/L) =
1 part per million (ppm)
Or 1 minute over 2 years or 4 drops in a 55 gallon drum.

Comparison Values

Concentrations, or “levels”, of elements that establish their abundance in the Earth’s crust or their risk to human health; examples:

- **Crustal Averages** – average concentrations of elements in Earth's crust, based on published USGS Prof. Paper 1270 (1984) and *CRC Handbook of Chemistry and Physics,* 97th edition (2016– 2017), p. 14-17 (chart shows top 8 elements)
  - We most often **use crustal average concentrations** for comparison purposes
- **Soil Screening Levels** – maximum concentrations of elements in soils adopted as regulations or guidelines and often based on lifetime risk of cancer (NM SSL, USEPA PRGs)

Soil results

- **Impacts of mining on agricultural soils *were not detected in our sampling sites***
- Uranium, vanadium, arsenic and lead in soils from the mine site and croplands compared with average "background" levels in western US in soils, as reported in USGS 1984
- Uranium was higher than the **background level** (2.5 mg/kg) in the topsoil *only* at the three Jackpile Mine sampling locations
- Arsenic and lead in soil near or above background regional levels is not uncommon; the presence of these metals may be related to the geology of the area where soils were sampled

- ***Soils inside Jackpile Mine are still contaminated and should be avoided***
  - Concentrations of uranium (4.4-48.4 mg/kg) and vanadium (217.8 mg/kg) in the topsoils at the mine sites (~ 3 km from the village) are *higher than the natural background levels*

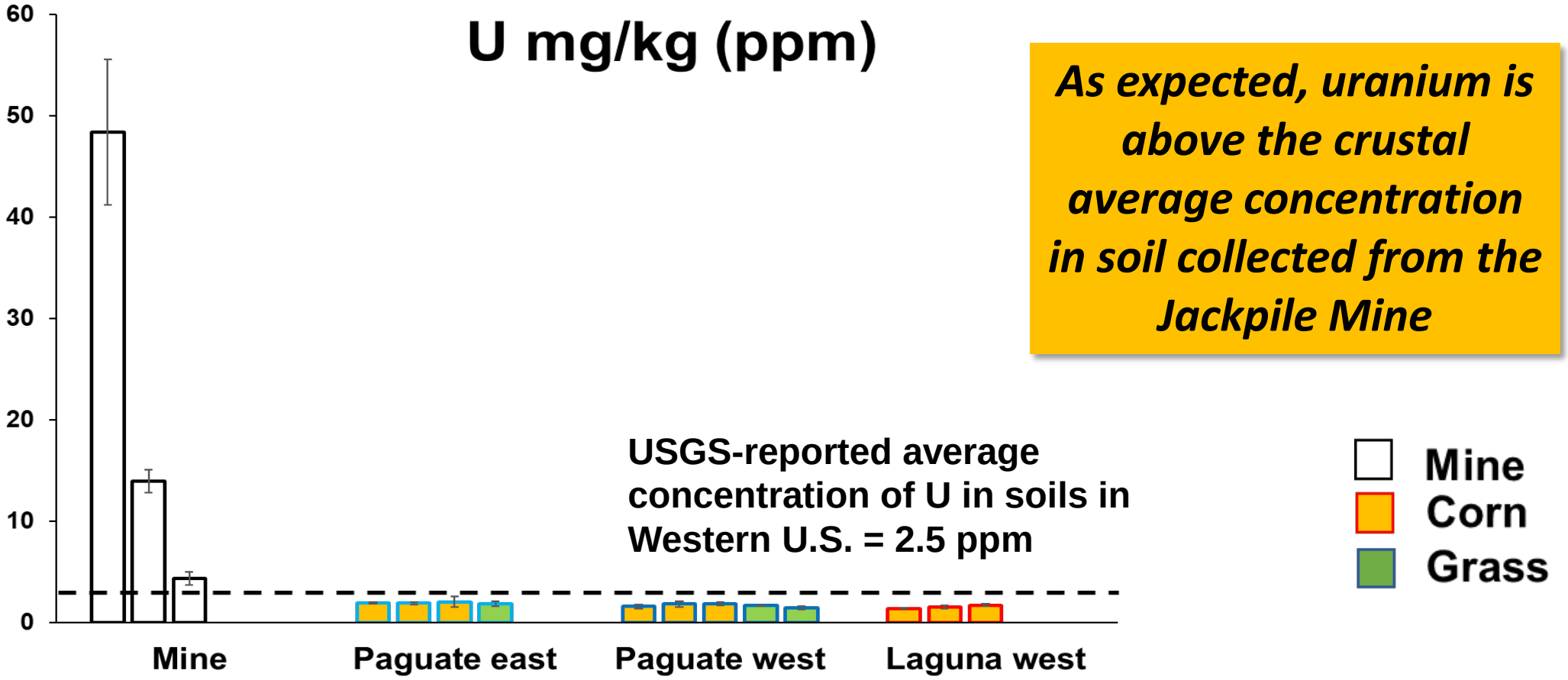
Crop results

- Metals that are of potential human health concern, including arsenic and lead, were detected ***below*** health-based guidance in all fruiting vegetables
- Lead and arsenic mainly accumulated in the roots of all crops at the farmlands that are close to the mine waste sites
- Concentration in roots are a little higher than recommended, only few samples were analyzed
- Remember: All plants you eat, including those grown in Laguna, contain *very small* amounts of metals that occur naturally in Mother Earth

Important notes related to crop results

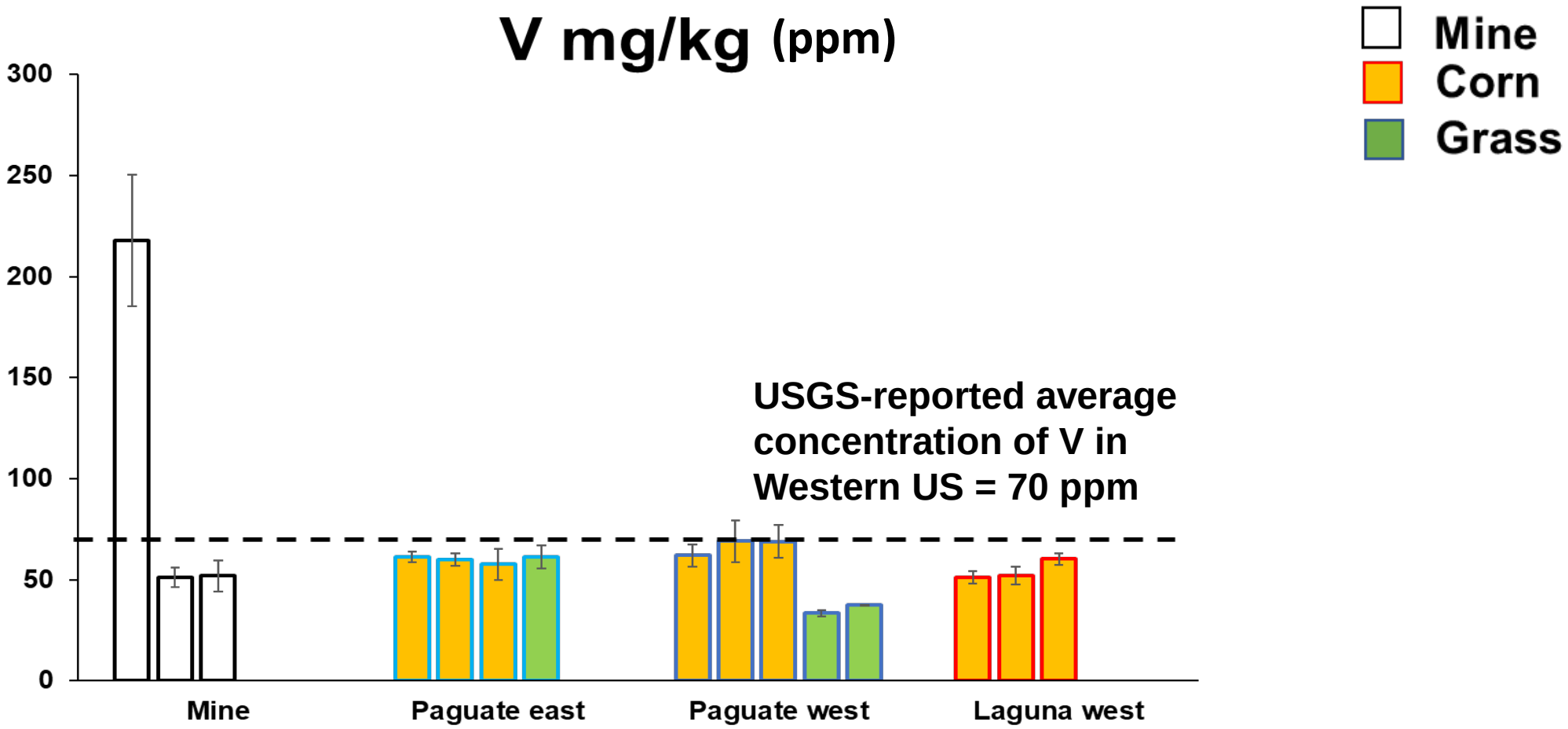
- The United States Food and Drug Administration (FDA) has ***no limits or recommendations*** for lead and arsenic in fruits or vegetables.
- We compared metals levels in plants with the levels listed by the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO).

Uranium (U) in soils

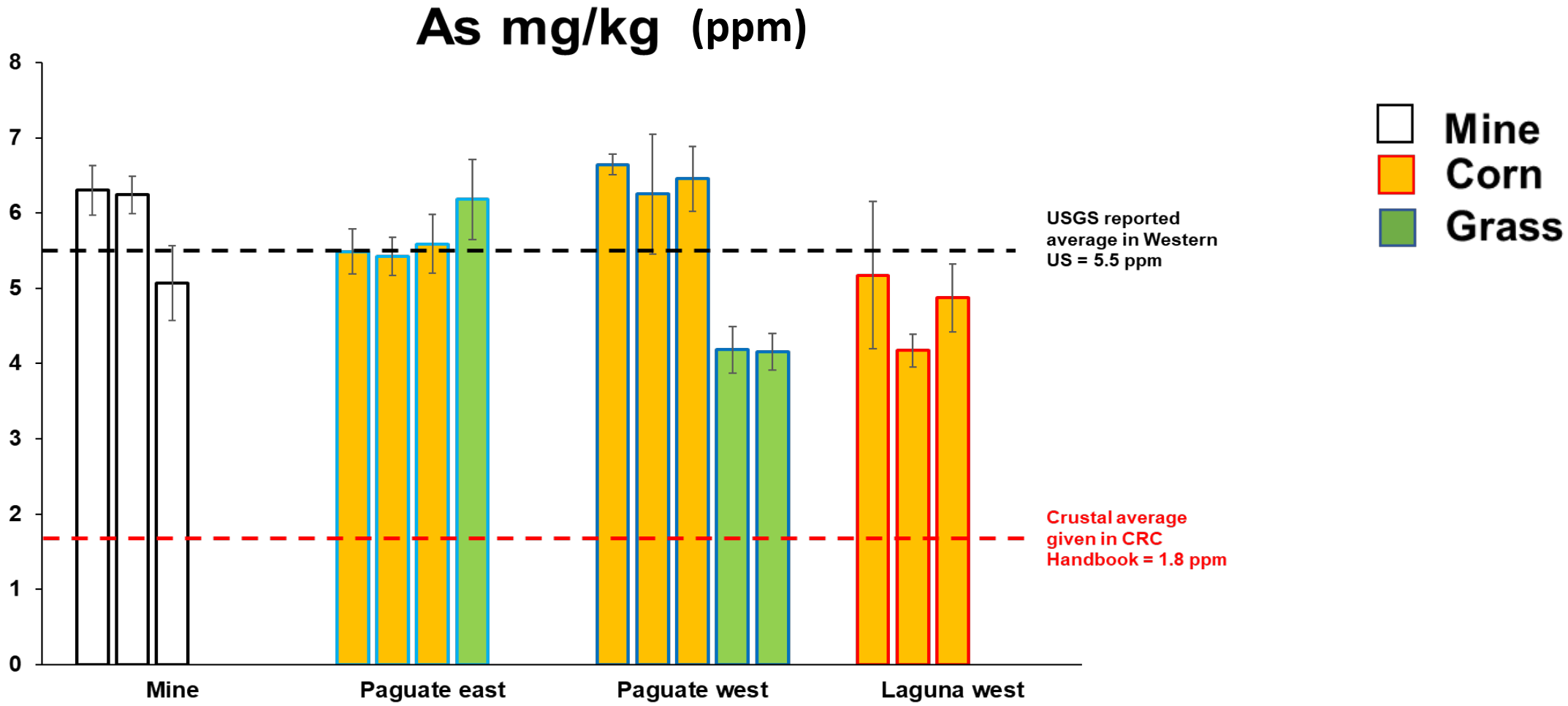


As expected, uranium is above the crustal average concentration in soil collected from the Jackpile Mine

Vanadium (V) in soils

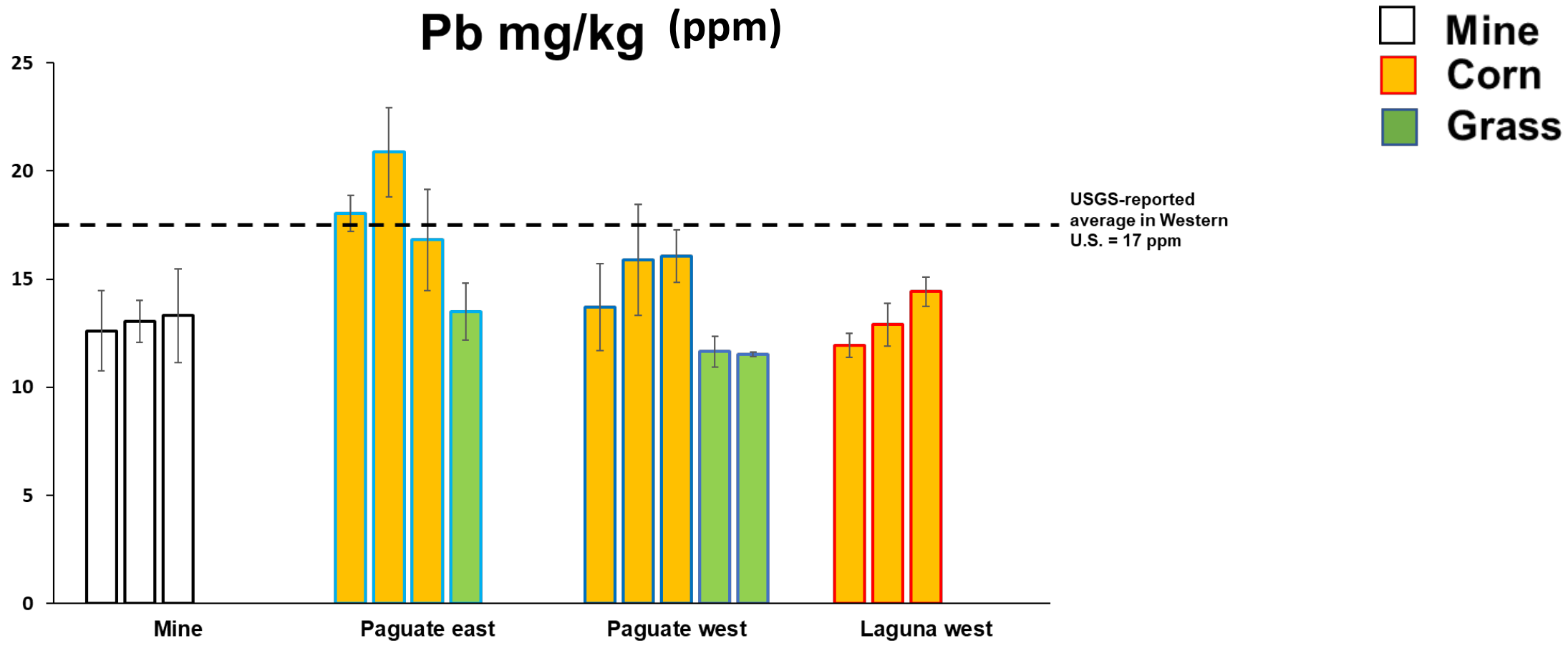


Arsenic (As) in soils



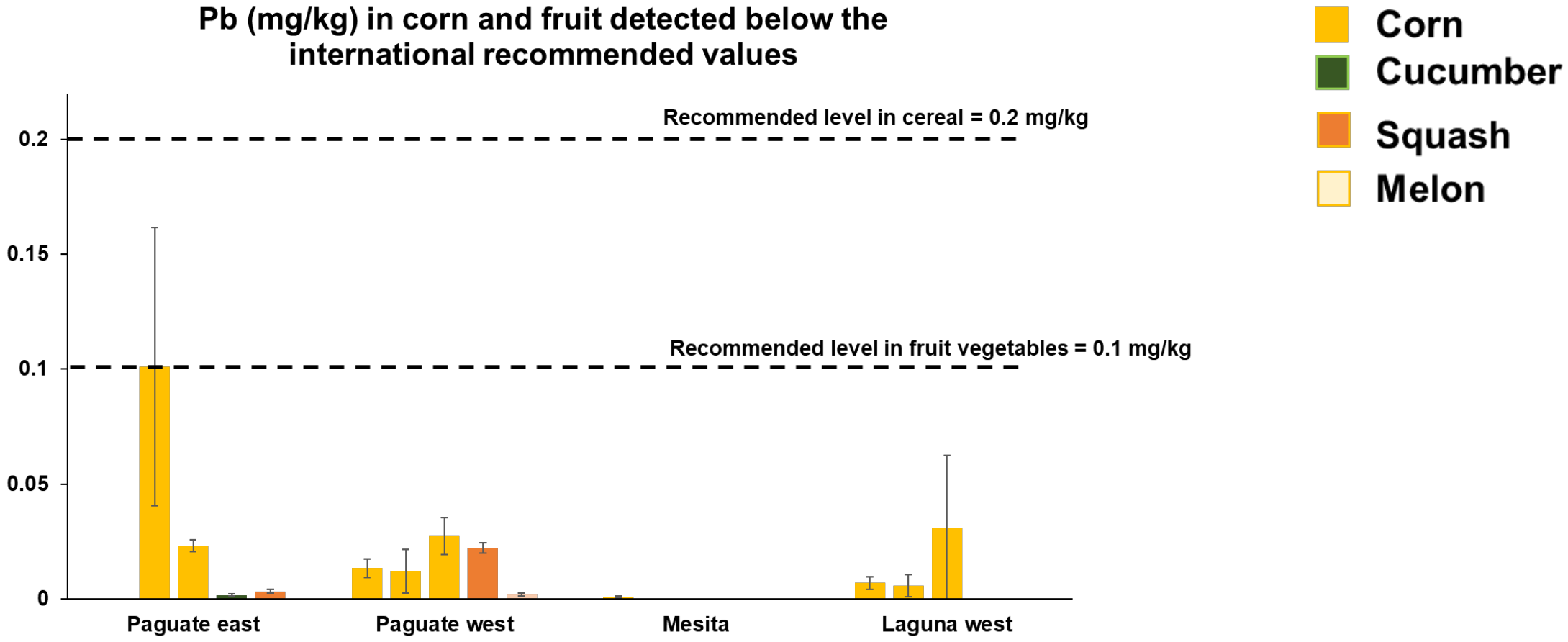
As levels in tested soils are around the USGS reported level in Western US

Lead (Pb) in soils



Pb levels in tested soils are below or around the USGS reported level in Western US

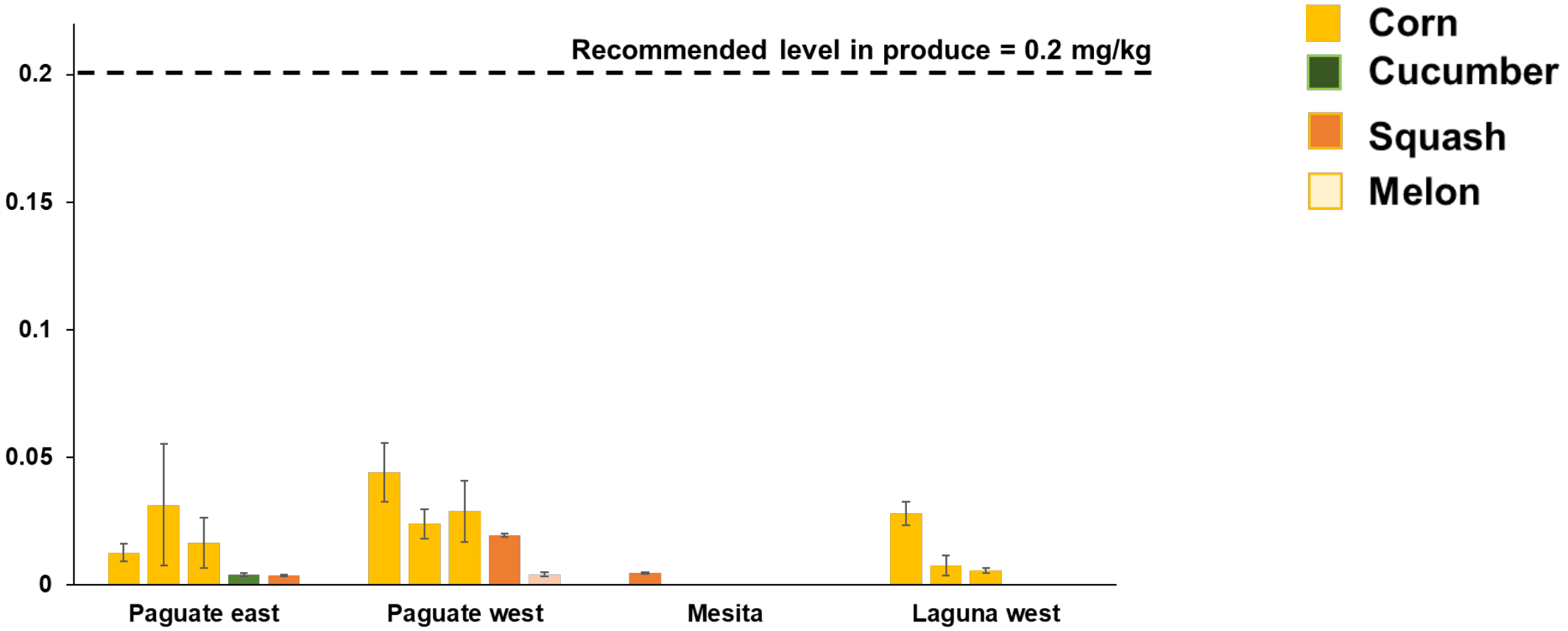
Lead (Pb) in produce



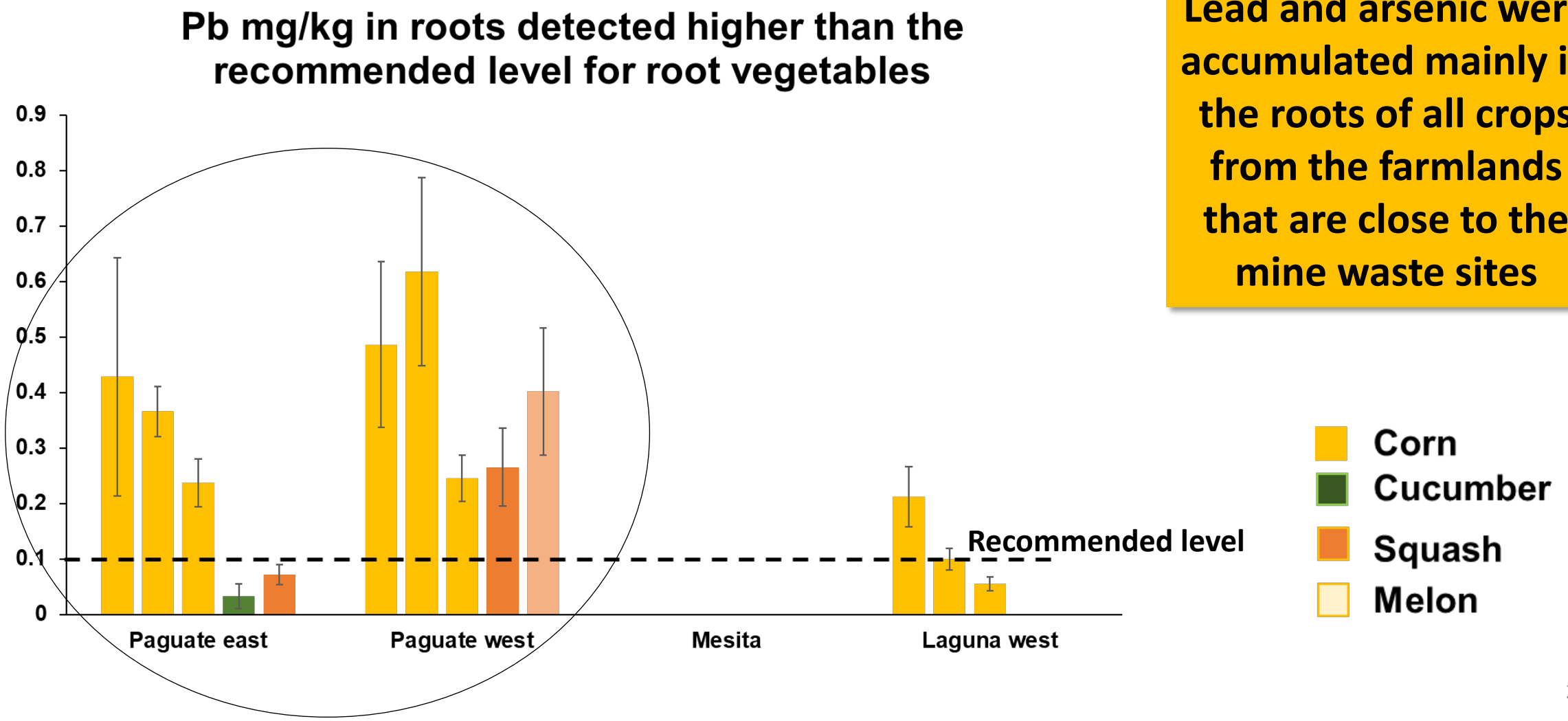
Pb levels in the tested fruiting vegetable are below the international recommended values

Arsenic (As) in produce

As (mg/kg) in fruiting vegetables detected below the international recommended values

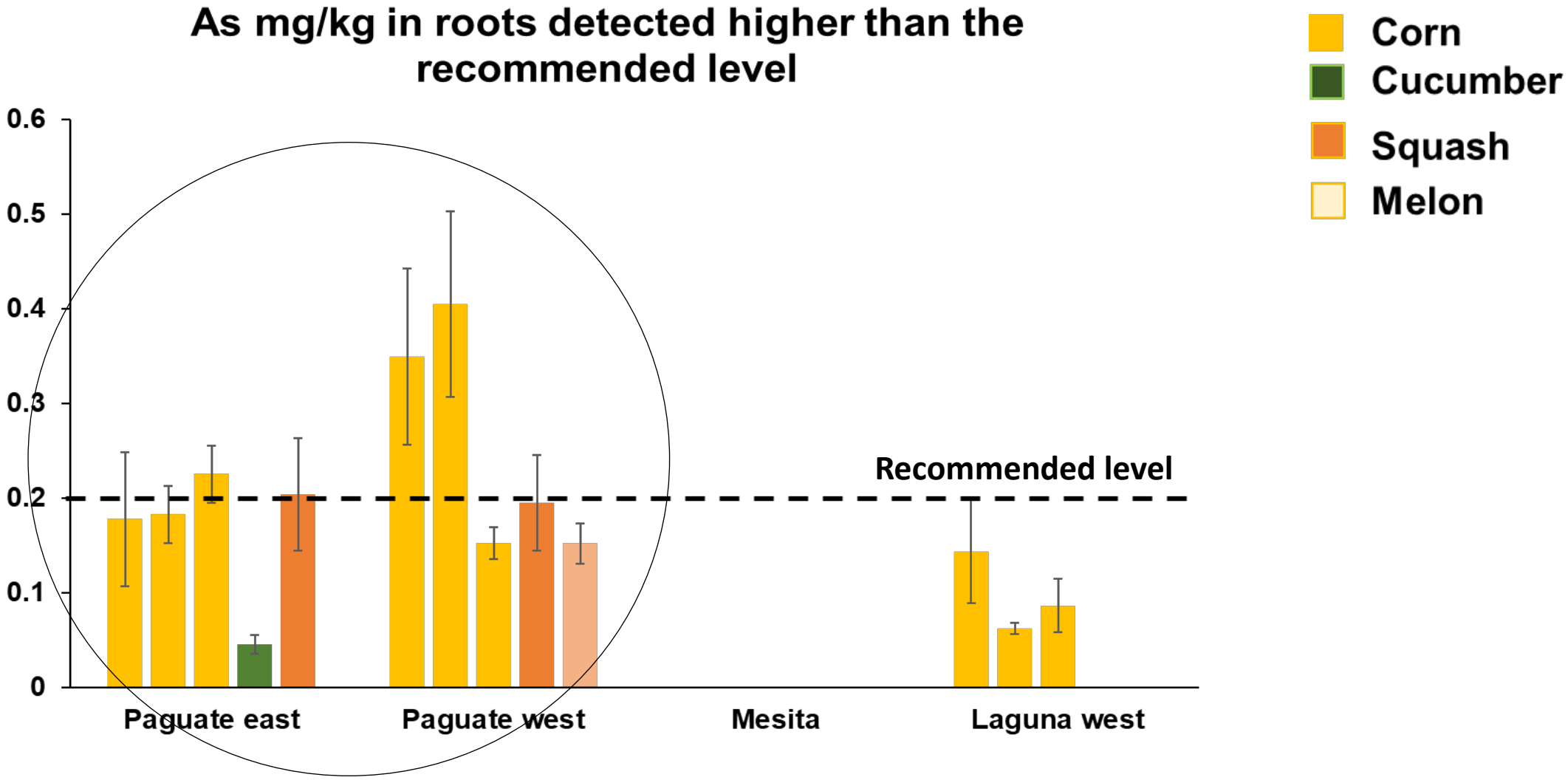


Lead (Pb) in roots



Lead and arsenic were accumulated mainly in the roots of all crops from the farmlands that are close to the mine waste sites

Arsenic (As) in roots



Recommended Community Actions

- Use specifically selected clothes only for gardening, farming
- Wash hands thoroughly after gardening
- Keep children's hands clean while in the field, discourage touching their mouths with dirty hands
- Wash fruiting, leafy and root vegetables before eating them

Surface Water Quality Sampling

- METALS – Sampling of Rio Paguate, 2014-2021; Rio San Jose 2017, 2020; nearly 80 samples
- Supplements surface water sampling by ENRD under Clean Water Act grants from EPA
- Published paper, research brief on Jackpile Mine impacts on water quality in Rio Paguate
- Data shared with ENRD
- Maintaining database of Laguna surface water quality data

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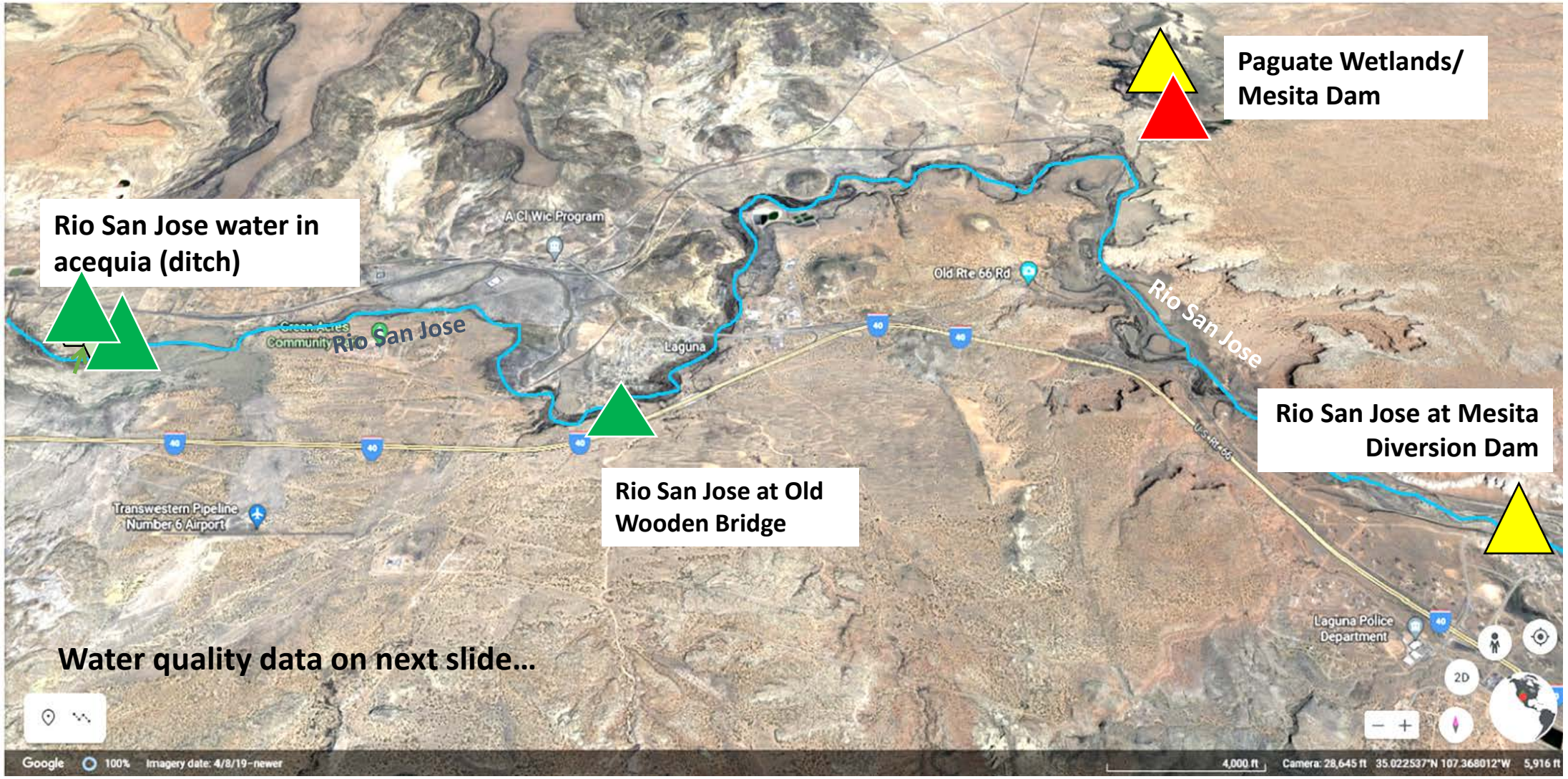
Water Quality in Rio San Jose and Paguate Wetlands/Mesita Dam, 2015-2021

Cond = Conductivity µs/cm (a measure of salt content); U = uranium (µg/l);

green = good; yellow = use caution; red = don't drink!



Selected Water Quality Data for Rio San Jose and Paguate Wetlands/Mesita Dam, 2015-2021

(legends on previous slide)

Rio San Jose water in acequia (ditch)

8/26/20	#16	U	**3.34**
8/26/20	#17	U	**3.66**
8/26/20	#16	Cond	**229**
8/26/20	#17	Cond	**513**

Rio San Jose at Old Wooden Bridge

6/2/2017	U	**6.13**
3/24/2017	Cond	**1501**
6/2/2017	Cond	**1914**
4/16/2021	Cond	**1166**

Rio San Jose at Mesita Diversion Dam

3/24/2017	U	**7.98**
3/24/2017	Cond	**1880**
6/2/2017	Cond	**4129**

Paguate Wetlands/Mesita Dam

Period	# samples	Parameter	Ave.	Min.	Max.	Std.
2015-2017	**14**	**U**	**36.4**	**5.46**	**110.41**	**30 ug/l**
6/2/2017	**1**	**Cond**			**2107**	**~750-800 uS/cm**

Take-home message: Rio San Jose is LOW in uranium, but increasingly salty from west to east. Paguate Wetlands/Mesita Dam water LOW to HIGH in U; moderately saline.

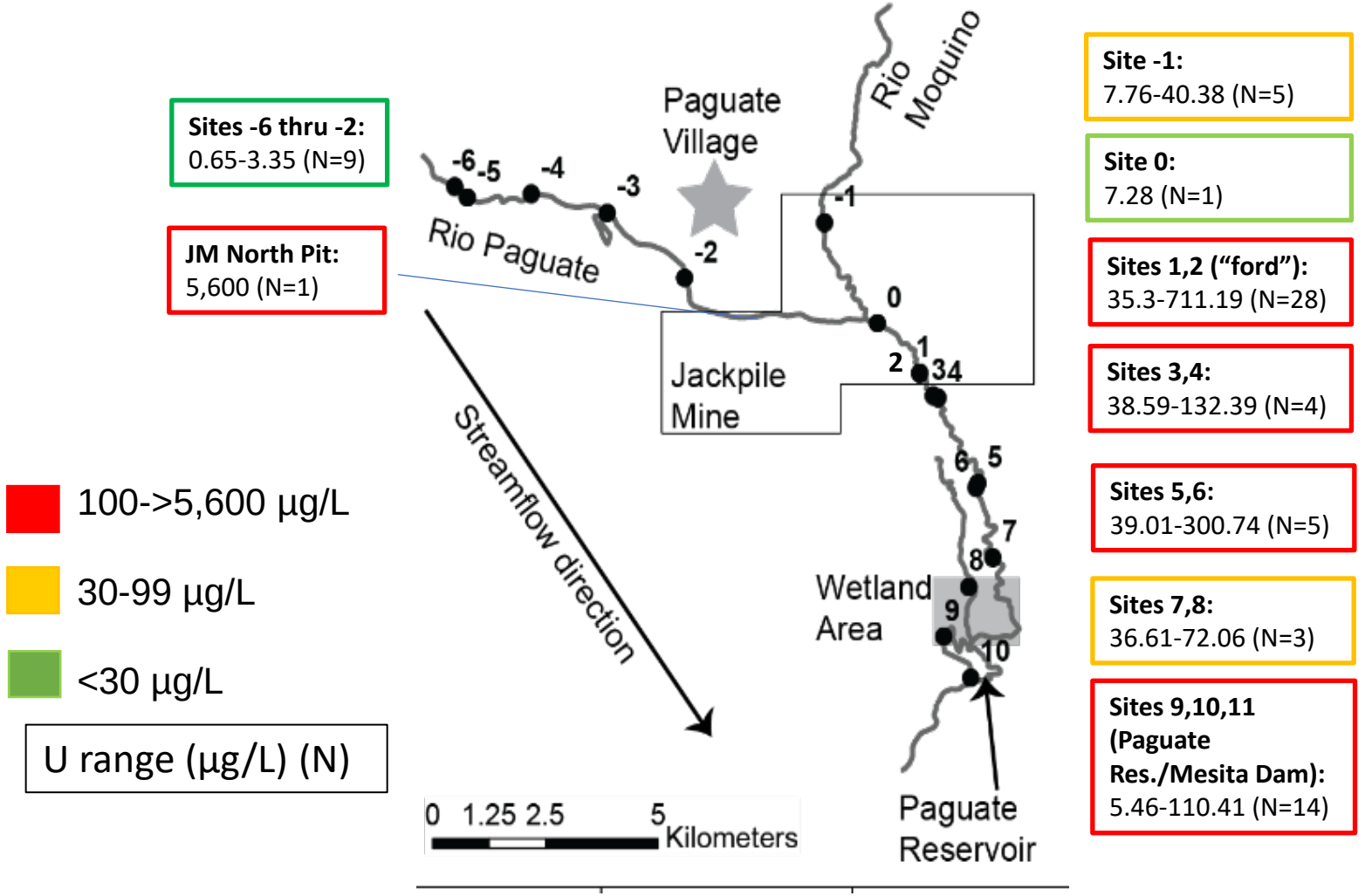
Note: *Laguna ENRD routinely samples and tests waters in streams on the Pueblo of Laguna as part of its surface-water monitoring program funded by USEPA Region 6. The data presented here were generated by the METALS SRP team and supplement data from sampling conducted by ENRD.*

Uranium Concentrations in Rio Paguate System, Pueblo of Laguna, 2014-2021

(Sources: UNM METALS SRP, Laguna ENRD, Precient Technologies)

Findings for Rio Paguate:

- Water EXCELLENT for irrigation upstream of North Pit (green): low U, low salts (Sites -6 thru -2)
- *Abrupt* worsening of water quality inside Jackpile Mine (red) (sites 0-6)
- Uranium in Rio Paguate wetlands behind Mesita Dam varies from good to poor, depending on flows (sites 7-11)
- No human consumption documented of Rio Paguate water inside and downstream from Jackpile Mine; wildlife, livestock exposed inside mine



What's next? (Further questions)

- Soil and plant sampling limited to 23 locations representative of current conditions in the communities, but they may not be reflective of metals levels throughout the Pueblo
- Next soil sampling should prioritize fields in Mesita, other ag lands
- Continuing presence of high uranium and vanadium concentrations in soils in the Jackpile Mine *requires further investigation*
- UNM returning collection of samples (executing promises)

Dawaeh (Thank you)

To all the villages of the Pueblo of Laguna!

Derek Capitan, Kelsie Herzer, Casey Miller, Kyle Swimmer, Luna Natoli, Chris Shuey, Abdul-Mehdi S. Ali, Paul Robinson, Michael Spilde, Adrian J. Brearley, Jennifer Rudgers, Eliane El Hayek, José M. Cerrato

Research team practicing social distancing, August 2020

These results are summarized in a poster prepared by Derek Capitan at the UNM Research Day, April 28, 2022, and shared with National Institutes of Health (NIH) officials on tour of Jackpile Mine on April 29.

Metal occurrence in agricultural lands near legacy uranium mine sites in the southwestern US using a community-engaged study

Co-authors: Derek Capitan, Kelsie Herzer, Casey Miller, Kyle Swimmer, Chris Shuey, Abdul-Mehdi S. Ali, Michael Spilde, Adrian J. Brearley, Eliane El Hayek, José M. Cerrato

Guuwaadzi haupa- Our work evidences the importance of developing a community driven research to work together and bring scientists, gardeners and farmers as a team to answer community concerns and investigate mining legacy.

METALS scientist working with gardeners and the community members in collecting soil samples, Summer 2020

METALS scientist Luna Natoli trains community members in collecting soil samples, Feb. 2020

Mining legacy near indigenous community

The New Mexico, Laguna Pueblo, Jackpile Mine
-Villages are less than 1 km from mine site
-Largest open pit uranium mine in 1960's

Vietnam Veteran's Road View of Jackpile Mine, Apr. 2022

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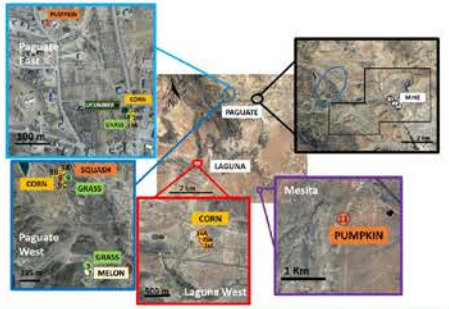
Local farmers, gardeners and growers volunteered to work with the scientists from the UNM METALS Superfund Research Center and the Pueblo of Laguna Environmental and Natural Resources Department (ENRD) to address a key community concern: *Is my soil impacted with metals associated with mining?*

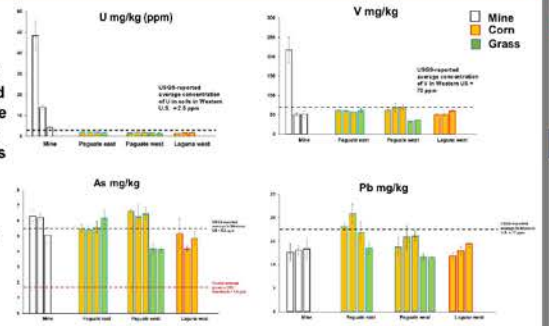
What's in my garden?

Site No	Village	Samples
3 (garden)	Paguate	soil, pumpkin
7 (garden)	Paguate	soil, melon, grasses
9 (farm)	Paguate	soil, corn, squash, grasses
11 (garden)	Mesita	soil, pumpkin
16 (farm)	Laguna	soil, corn
18 (garden)	Paguate	Soil, corn, cucumber, grasses
Jackpile Mine	Paguate	Soil, grasses, roots

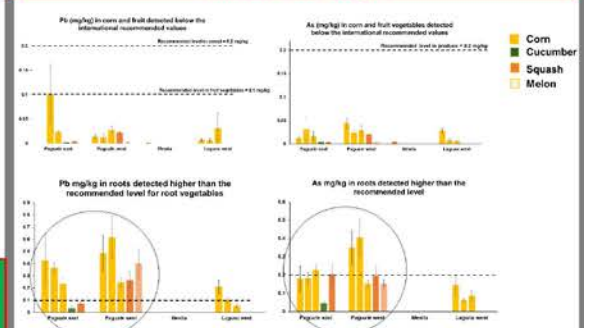


Metals in soil

Concentrations of U (4.4-48.4 mg kg^{-1}) and V (217.8 mg kg^{-1}) were measured in the top soils at the mine sites (~ 3 km from the village), which are higher than the natural background levels.

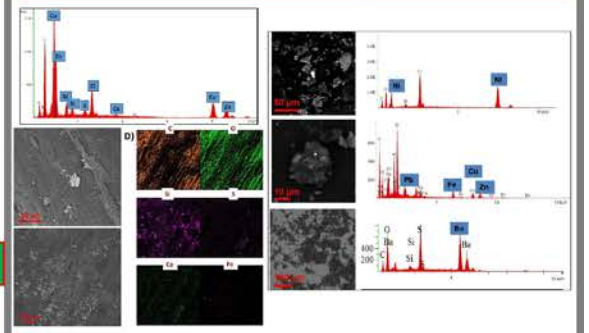


Metals in crops



Metals that are of potential human health concern, including U, V, As and Pb, were detected below health-based guidance in all fruit vegetables and corn. Pb and As were identified mainly accumulated in the roots of all crops (0.1-0.3 mg per kg fresh weight) at the farmlands that are close to the mine waste sites

The dust and the surface of leaves as tracers of atmospheric deposition



Our results show that the nature of bioaccumulated metals, including metals particulates, near abandoned mine sites can provide critical information for human exposures in sites affected by mining legacy.

Acknowledgments

NIH NIMHD
NIH
NIH National Institute of Environmental Health Sciences
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