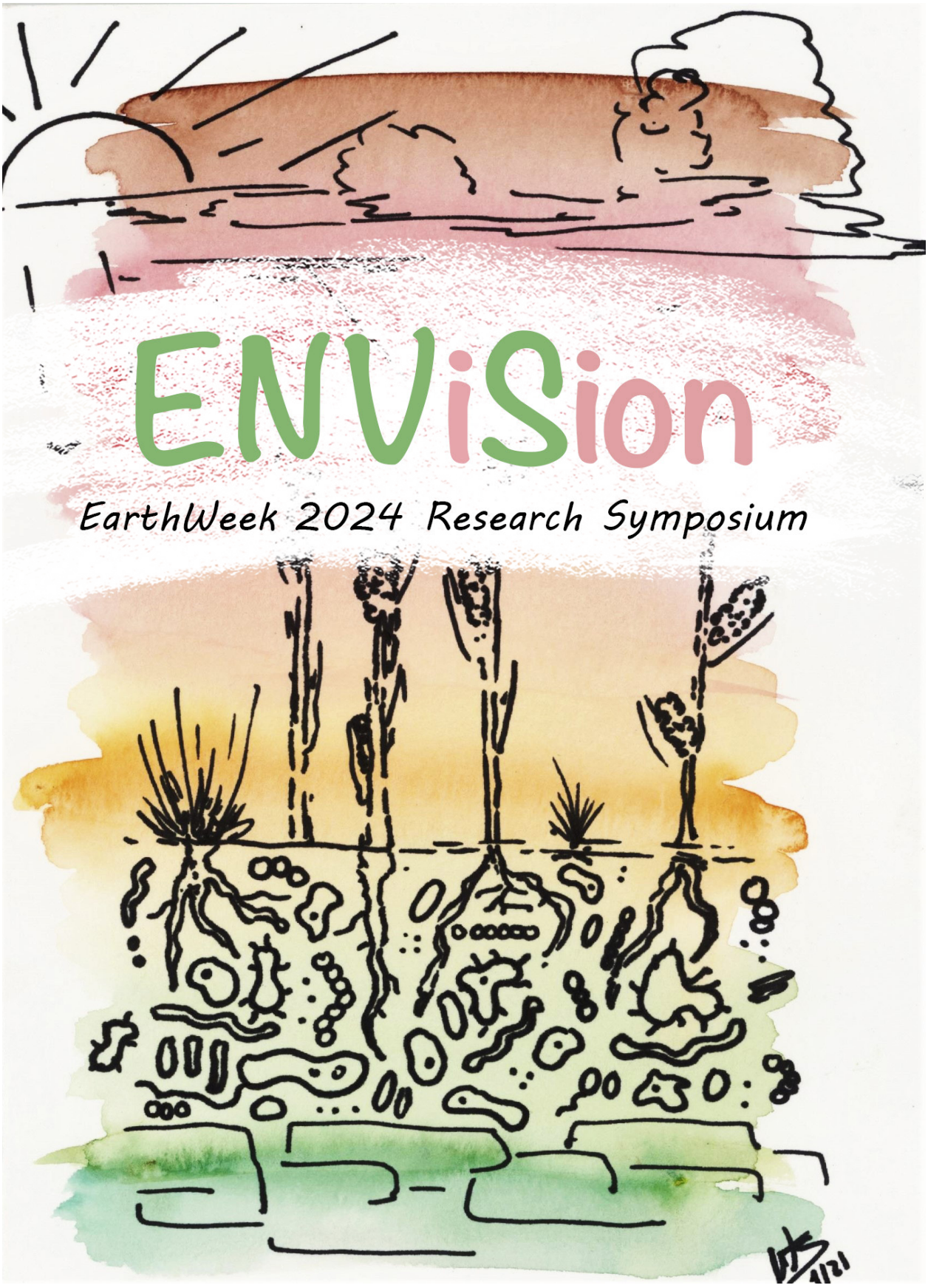

ENViSion

EarthWeek 2024 Research Symposium

COLLEGE OF AGRICULTURE, LIFE & ENVIRONMENTAL SCIENCES

Environmental Science

Contents

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Welcome to ENViSion 2024!

ENViSion is the annual in-house scientific conference for the University of Arizona Department of Environmental Science. This student-run event is part of the School of Earth and Environmental Sciences EarthWeek celebration, showcasing the research produced by our graduate and undergraduate students as an opportunity for networking, finding collaboration opportunities, and for communicating science to the greater community. We want to extend our thanks to our volunteers and sponsors without whom we would not have such a wonderful event. Please enjoy the day and we hope you will join us again next year!

Sincerely,

The ENViSion Committee
Anu Sethuraman
Neera Setlur
Ben Karls
Susan Perez

Oral Presentations - Morning Session

9am Godsgift N. Chukwuonye - Advised by Dr. Mónica D. Ramírez-Andreotta

Toxic Layering and Compound Events: Per- and Polyfluoroalkyl Substances (PFAS) Exposure After Extreme Climatic Events in Rural, Environmental Justice Mining Communities

Per- and Polyfluoroalkyl Substances (PFAS) are persistent chemicals increasingly scrutinized due to their health risks and environmental persistence. The distribution and sources of PFAS in surface soils were examined in the Globe/Miami areas, located in Gila County, Arizona, USA, which are characterized by active and historical mining operations and are concomitantly susceptibility to extreme climate events like wildfires and floods. Using Liquid Chromatography-Tandem Mass Spectrometry (LC-MS/MS), composite surface soil samples from residential (n=35) and control sites (n=8) were analyzed for 28 PFAS compounds. Multiple linear regression, Spearman correlation, Kruskal-Wallis test, and spatial analyses were conducted to investigate their correlation with heavy metals (As, Cd, Pb), and assess spatial distribution patterns in relation to potential PFAS sources. Key findings indicate that total PFAS concentrations were significantly greater in soils from residential areas affected by flooding compared to control samples, suggesting an enhanced mobilization of PFAS due to flood events.

9:10am Neeraja Setlur - Advised by Dr. Jon Chorover

In-Situ Sequestration of PFAS from Contaminated Groundwater using an Injectable High Affinity Cationic Hydrophobic Polymer

The urgency to efficiently remove Per- and polyfluoroalkyl substances (PFAS) from water systems has grown with increased media coverage and political activity. PFAS are a group of over 4000 synthetic compounds designed for diverse commercial uses presenting challenges in water treatment due to their complex chemical structures. PFAS accumulation in organisms leads to documented health concerns, including thyroid, heart, and liver diseases in humans and animals. Current PFAS remediation involves costly ex-situ pump-and-treat methods and in-situ injection of adsorbents (e.g., colloidal activated carbon (CAC) and ion exchange resins). While more efficient than ex-situ technologies, injectable adsorbents are not optimized for a broad PFAS range and have poor adhesion to aquifer matrices. This project synthesized and tested a high-affinity cationic hydrophobic colloidal polyaniline (cPANI), exhibiting comparable adsorption efficacy to CAC at environmentally relevant PFAS concentrations and significantly improved adhesion to sand. This innovation holds promise for enhancing PFAS remediation efficiency.

9:20am Tomasz Wlodarczyk - Advised by Dr. Alicja Babst-Kostecka

Advances in the identification of metal uptake in native vegetation of the U.S. Southwest

Phytomining is a green alternative to conventional methods of extracting metals from enriched substrates. It is particularly promising for non-standard metal sources such as legacy mine wastes. At the heart of phytomining are metal-craving plants (hyperaccumulators) that accumulate metals in their foliage, which can be later recovered and reused. However, our limited knowledge of hyperaccumulators in arid and semi-arid regions has hampered the broad application of phytomining in these climates. Here, we present extensive field surveys on post-mining sites across Arizona that allowed us to identify new hyperaccumulators with potential for application in phytomining across the U.S. Southwest. To facilitate the identification of new candidate species across larger areas, we integrated hyperspectral remote sensing and explored spectral features of plants with varying metal concentrations in their biomass. This technology could revolutionize the process of identifying hyperaccumulators and serve as a comprehensive planning and monitoring tool for phytoremediation operations.

9:30am Viviana Freire-Zapata - Advised by Dr. Malak Tfaily

Multi-omics reveals functional shifts underpinning microbial Responses to Resource Availability Shifts in Arid Environments

Climate change progression is expected to cause erratic and extreme weather patterns, with a potential decrease in precipitation frequency but an increase in intensity. Such changes pose a threat to the stability and functionality of soil microbiomes. Droughts and increased precipitation can trigger significant shifts in metabolic reactions and biogeochemical processes, particularly in arid ecosystems. However, the exact mechanisms by which drying and rewetting events drive microbial soil processes and influence their adaptability potential to a changing environment remains unclear. To address this gap, we harnessed multi-omics approaches, encompassing metagenomics, metatranscriptomics, amplicon sequencing, metabolomics to illuminate the adaptive strategies of key microbial guilds. Our analyses of 32 soils collected across the 2021 North American monsoon season revealed dramatic functional shifts unlocking microbial responses to shifts in water and nutrient availability. As rain arrived, we observed the upregulation of diverse pathways. Metabolomics analysis expanded these insights. Ultimately, we elucidated the genomic

9:40am Maria (Mery) Touceda-Suarez - Advised by Dr. Albert Barberan

Differences in the genetic potential of soil microbial communities of urban greenspaces vs. natural arid soils.

Urban greenspaces provide essential ecosystem services that are ever more important in arid cities. Specifically, microbial communities in urban soils are responsible for soil stabilization, water regulation, carbon storage, nutrient cycling, and pollution regulation. However, urbanization causes changes in the soil environment which influence soil microbial dynamics in ecosystem-dependent ways. In this project, we leveraged the metagenomic information from soil microbial communities of urban greenspaces and neighboring natural areas in a city from the arid Southwestern USA (Tucson, Arizona). We found that urban greenspaces harbor structurally and functionally different soil bacterial and phage communities, the former showing signs of specialization in the decomposition of simple plant-derived sugars, higher potential for denitrification, and higher resistance to heavy metals and clinical antibiotics. Our results provide evidence for the role of soil microorganisms in the shifts in ecosystem dynamics produced by the expansion of urban greenspaces in arid lands.

10:05am Christian Ayala-Ortiz - Advised by Dr. Malak Tfaily

Metagenomic Insights into Microbial Adaptations to the North American Monsoon in Southwestern Arid Soils

Dryland ecosystems cover around 40% of the terrestrial surface and are expanding due to climate change. In the arid Southwestern USA, the North American monsoon, drives biological activity by alleviating water limitation. However, climate-induced shifts in temperature and rainfall patterns may mimpact microbial community activity and carbon cycling in these water-stressed biomes. Because our ability to project ecological consequences is constrained by limited knowledge of our microbial communities' life strategies f under intermittent moisture regimes. Our study aims to elucidate genomic adaptations enabling microbial communities to capitalize on monsoon rains through the use of metagenomics. Our analysis revealed the prevalence of microbial groups characterized by high GC content (e.g., Actinobacteria) as well as groups known for their adaptability to arid conditions (e.g., Thermoproteota). It also indicated an increase in the number of encoded genes related to hydrocarbon degradation, central carbon metabolism and energy production in genomes recovered during the rains

Oral Presentations - Morning Session Continued

10:15am Adela Maria Reynoso - Advised by Dr. Craig Rasmussen

Exploring the potential for enhanced weathering for carbon sequestration in Arizona agricultural systems

Enhanced weathering of volcanic rock provides a climate-smart approach to agriculture that can potentially boost crop productivity and mitigate climate change effects through carbon sequestration. Crushed basalt is commonly used to amend soils for accelerated mineral transformation and nutrient release for crop uptake; furthermore, this weathering process promotes carbon drawdown from the atmosphere and stores it in the soil in inorganic forms. This study quantifies enhanced weathering and its effect on crop growth and carbon sequestration through a 9-month greenhouse experiment. Soil samples were collected from the Red Rock Agricultural Center, 30 miles north of Tucson, AZ. A fully factorial experiment was conducted growing alfalfa (Medicago sativa), the largest crop by acreage in Arizona, and blue grama (Bouteloua gracilis), a key native grass in rangeland management systems. Initial soil biogeochemical analysis showed variations among the four amendments as reflected decreased respiration from basalt-amended soils, suggesting increased partitioning of CO2 to

10:25am Manzeal Khanal - Advised by Dr. Alicja Babst Kostecka

Unlocking plant-metal-microbe interactions: exploring Atriplex spp. as native flora in the US Southwest

Phytoremediation using native plants is a trending approach to reclaim heavy-metal polluted sites. However, there is a limited understanding of the roles played by microbes in alleviating metal stress, promoting plant growth, and regulating metal uptake in plants adapted to arid climates. To determine promising native plant candidates, we examined the leaf metal content of 23 species from legacy copper mine tailings in Arizona. We found Atriplex canescens to be the only species that accumulated Zinc and Copper. As A. lentiformis is a closely related congeneric species that excludes metals, we aim to explore the differences in microbe-mediated metal tolerance and accumulation in these two Atriplex species. Using controlled conditions, phenotyping experiments will be conducted to quantify responses to altered soil microbiomes. By integrating various tools including genomics, transcriptomics, and metabolomics, we will dissect the putative role of soil microbes as drivers of successful phytoremediation in an arid region.

10:35am Brooke Byars - Advised by Dr. Jon Chorover

Soil Predictors of Coccidoides posadasii Presence in Arizona

Coccidioidomycosis, or “Valley Fever,” is a disease caused by inhalation of the soil-borne fungal arthroconidia (spores) of Coccidioides spp. More than 20,000 cases of Coccidioidomycosis were reported to the CDC in 2019, with most of the cases occurring in residents of highly endemic areas (California’s San Joaquin Valley [C. immitis] and Arizona’s Sonoran Desert [C. posadasii]). Coccidioides is not evenly distributed throughout these endemic areas, instead it is found in “hotspots”. Factors controlling the geographic range and distribution of Coccidioides are not well defined, although soil, climatic, and environmental properties are expected to be important. Additionally, the ecological niche of Coccidioides is still poorly understood, and it remains uncertain whether these fungi are mainly linked to small mammals, such as burrowing rodents, or if they exist as saprotrophs in soil. Work is ongoing to determine soil characteristics and conditions that are essential to fungal growth and to constrain C. posadasii

10:45am Jacob Galloway - Advised by Dr. Alicija Babst-Kostecka

Exploring Metal Tolerance and Accumulation in Plants: Hydroponic Tolerance Tests and Applied Strategies for Metal Uptake from Contaminated Waters.

Hydroponics offers a convenient laboratory method for plant research, providing precise control over growth conditions and overcoming biases introduced by soil heterogeneity. This method enables a continuous supply of bioavailable elements in the solution and easy access to root structures. Consequently, hydroponics is the ideal approach for studying heavy metal tolerance in plants. Tailoring hydroponic solutions on a per-plant basis allows for accurate quantification of heavy metal uptake, stress patterns, and nutrient effects across species, populations, and at the individual level. This approach promises insights into plant-metal tolerance indices, metal uptake patterns, elemental distribution in plant tissues, and the overall impact of heavy metals on plant growth. By leveraging hydroponics, researchers can enhance the precision and applicability of their findings in addressing environmental challenges, including applications in wastewater treatment strategies.

10:55am Taylor Thornton - Advised by Dr. Luisa Ikner

Surrogate Virus Decay and Effects in B2 Soils

Resident soil viruses are an important component of soil ecosystems and can shift microbial communities and alter metabolic processes. However, it is unclear whether non-resident viruses, introduced to the soil can remain viable and effect the composition and functional activity of resident bacterial communities in soil. The objective of this study was to assess the survival over a 21-day period of three introduced bacteriophages: PhiX-174, MS2, and Phi-6. Soil microcosms were prepared using samples collected from five distinct ecosystems located within Biosphere 2: rainforest, savanna, thorn scrub, desert, and ocean (beach). Phi-6, an enveloped virus serves as a surrogate for SARS-CoV-2, was inactivated within 24 hours to levels below detection in all but two soils. MS2 and PhiX-174 are non-enveloped surrogate viruses for human enteric pathogenic viruses, both had consistently high recoveries initially. However, PhiX-174 was the most stable compared to MS2, as demostated by lower decay rates.

Oral Presentations - Afternoon Session

1pm Taylor Arp - Advised by Dr. Debankur Sanyal

Is Deficit Irrigation to Conserve Water Sustainable for Commercial Agriculture in the Desert?

Deficit irrigation strategies are often considered an effective irrigation technology to conserve water and were tested in different crop production systems and environments. We investigated deficit irrigation strategies in the desert Southwest, specifically central Arizona, for durum wheat and grain barley production under flood irrigation. The experiment was conducted at the Maricopa Agricultural Center, University of Arizona. We tested 10% and 20% irrigation deficits and found that only 10% deficit irrigation declined 30% and 45% grain yield in durum wheat and barley, respectively. We also did not record any changes in soil chemical properties or health. Our study concluded that under flood-irrigated durum wheat and barley grain production, deficit irrigation may not be an economically viable strategy for water conservation in desert agroecosystems. However, this study also indicated the need for similar research with drip or sprinkler-irrigated small grain production systems.

1:10pm Benjamin Karls - Advised by Dr. Katerina Dontsova

The Transport of Energetic Compounds in Overland flow in Arid Environments: A Case Study of Florence Military Reservation, Arizona, U.S.A.

In arid environments, where limited infiltration is observed, contaminants have the potential to be transported in surface flow. On military training ranges, where munitions are consistently used, there is continuous deposition of energetic residues on the soil surface. Explosives are deposited during partial detonations, while a small percentage of propellants are left after each firing. Residues can also remain after disposal of munitions. To better understand the transport of energetic contaminants in arid environments, soil samples were collected on a military installation from a firing range, demolition pits, and a stream channel that drains these sites to quantify surface transport caused by overland flow. Alongside soil samples, a Teledyne ISCO™ autosampler was utilized to measure flow and collect water samples from the ephemeral stream channel. The collected data was then compared to simulated results developed by the U.S. Army Corps of Engineers Fate and Risk Environmental System for Contaminants (FRESCO)™.

1:20pm Charlie Cunningham - Advised by Dr. Jon Chorover

Enhanced Rock Weathering on Basalt Hillslopes: Quantifying Carbon Capture via Concentration-Discharge Interactions

Carbon dioxide removal (CDR) via silicate-enhanced rock weathering (ERW) is proposed to manage the global carbon budget while simultaneously enriching agricultural soils. This study at the Landscape Evolution Observatory (LEO) at Biosphere 2 uniquely combines field-scale ERW experimentation within a controlled environment akin to laboratory settings. The experiment, conducted from fall 2022 to spring 2023, consisted of three serial and randomized 30-day pulsed precipitation events on triplicate basaltic hillslopes followed with progressively lengthened dry periods. Discharge samples were collected bihourly through the hydrograph for major and trace chemical analysis. CDR was quantified using bicarbonate concentration and charge balance. To compare efficacy of LEO to other studies, ERW was normalized to the specific surface area (m2g−1) of each basalt analyzed. Measured LEO CDR rates for each precipitation pulse ranged from 1.53 × 10−6to 2.05× 10−6 moles CO2 m−2 basalt surface. Other studies record values ranging from 10−6 to 10−4 moles CO2

1:30pm Abdullah Aleidan - Advised by Dr. Andrea Achilli

Adsorption model evaluation of perfluoroalkyl substances (PFAS) in saturated media

PFAS have been the target of increasing interest in recent years due to their persistence in environmental media and negative health effects on human health. This study conducted regression analysis on PFOS sorption results from 28 studies (n = 209) in order to analyze the effects of solid-phase properties on PFOS sorption, and evaluate the performance of 9 proposed sorption models (Kd) at environmental concentrations (0.05 mg/L and 0.1 mg/L).

1:40pm Jhon del Aguila Pasquel - Advised by Dr. Scott Saleska

Methane fluxes from soil and tree stem surfaces in flooded and non-flooded forests in the Central Amazon basin

Recently, the concentration of atmospheric methane (CH4) has sharply increased and the signature of carbon stable isotope in CH4 has become more negative suggesting biotic sources might be partly responsible of changes in atmospheric CH4 budget. We assessed the magnitude of CH4 fluxes from soil and trees across dry and wet seasons in two contrasting ecosystems in the Central Amazon basin: the seasonally flooded varzea and the upland terra firme forest. Overall, greater fluxes were released from the trees stems of the varzea forest during the first half of the dry season (June-August). Stem surfaces of upland trees emitted very low CH4 fluxes (< 1 mg m-2 h-1). Methane fluxes of most trees from the flooded forests decreased with stem height, a pattern not shown by tree fluxes in the upland forest. The fluxes from tree stem emissions varied by tree species in both forest types.

2:05pm Kunal Palawat - Advised by Dr. Mónica Ramírez-Andreotta

Garden-based community science: navigating layers of violence to achieve environmental health justice

Marginalized communities are denied access to healthy soils and knowledge about their environments, meaning that many people do not know the quality of their soil and the impact of contamination on health. Academic research often leaves out those who bear the brunt of corporate and government pollution. But, community-based research provides an opportunity to center local scientific questions and study layers of systemic violence to then inform community and national use of natural resources. This study aggregates citizen/community science data from 10 different communities across the United States to assess the effect of soil contamination, plant family, and environmental injustices on over 400 soil samples and nearly 1000 plant samples. These data are used to assess metal(loid) geochemical uptake patterns, calculate risk-based soil screening levels, and conduct an environmental justice human health risk assessment.

2:15pm Jason D. Windingstad - Advised by Dr. Craig Rasmussen

Sand Provenience Analysis of Eolian Archives in the Mohawk Dune Field, AZ

The Mohawk dunes in southwestern Arizona preserve regionally significant paleoenvironmental data in thick eolian soil-stratigraphic successions. These archives can help answer questions regarding paleoclimatic change, atmospheric circulation, eolian-fluvial dynamics, and arid zone soil-landscape evolution. These questions, however, cannot be fully addressed if the source of the dune sand remains unknown. To identify sand source areas this study used a combination of trace element geochemistry (EDXRF) and mineralogical analysis (Rietveld refinement of powder XRD data) of dune and upwind landforms. The results of this study indicate that modern eolian sand in the main body of the dunes originated from the distal bajada of the Cabeza Prieta mountains, a granitic and volcanic mountain range located 20 km to the southwest. Trace element data from linear dunes at the northern end of the dune field revealed combined sand sources from the Cabeza Prieta bajada and the floodplain of the Gila River.

Oral Presentations - Afternoon Session Continued

2:25pm Russell Noon - Advised by Dr. Craig Rasmussen

Sorption properties of microplastic particles and the potential mechanisms for terrestrial remediation

Representing particles smaller than 5mm in diameter, microplastics continue to contribute to anthropogenic environmental contamination. With the ability to sorb other environmental contaminants on and within their molecular structure, microplastics pose not just a hazard from the plasticizers they leach, but also the accumulated contaminants that desorb from their structure. These mechanisms of sorption and the associated photochemical degradation of the polymer structures offer a potential solution for remediating microplastics in terrestrial environments. Incorporation of both ionizing radiation and the redox potential of the microplastics' crystalline structure offer potential solutions to the degradation of microplastics for remediation.

2:35pm Raquel Ornelas - Advised by Dr. Mónica Ramírez-Andreotta

Do not shun us: Planting native species in communities impacted by mining pollution, desertification, and precarity.

Environmental Justice programs focused on underserved communities require a connection to the inhabitants, a joyful yet challenging on-the-ground activity. This research focuses on epistemological methodologies to reach out to local stakeholders aiming to implement environmental justice programs boosted from within society. One example is the collaborative work in Mátape, Sonora; locals planted Agave angustifolia, an endemic keystone species. The expected results have yet to be achieved. However, locals' enthusiasm grabbed the attention of organizations to support native vegetation planting with the available resources, people, territory, scientific knowledge, technical skills, materials, and teamwork; therefore, the program is under development now. The described events inspire this research to specialize in applying epistemological holistic methodologies to connect scientists, organizations, and society, with particular attention paid to people feeling shunned, to collaborate on environmental justice projects.

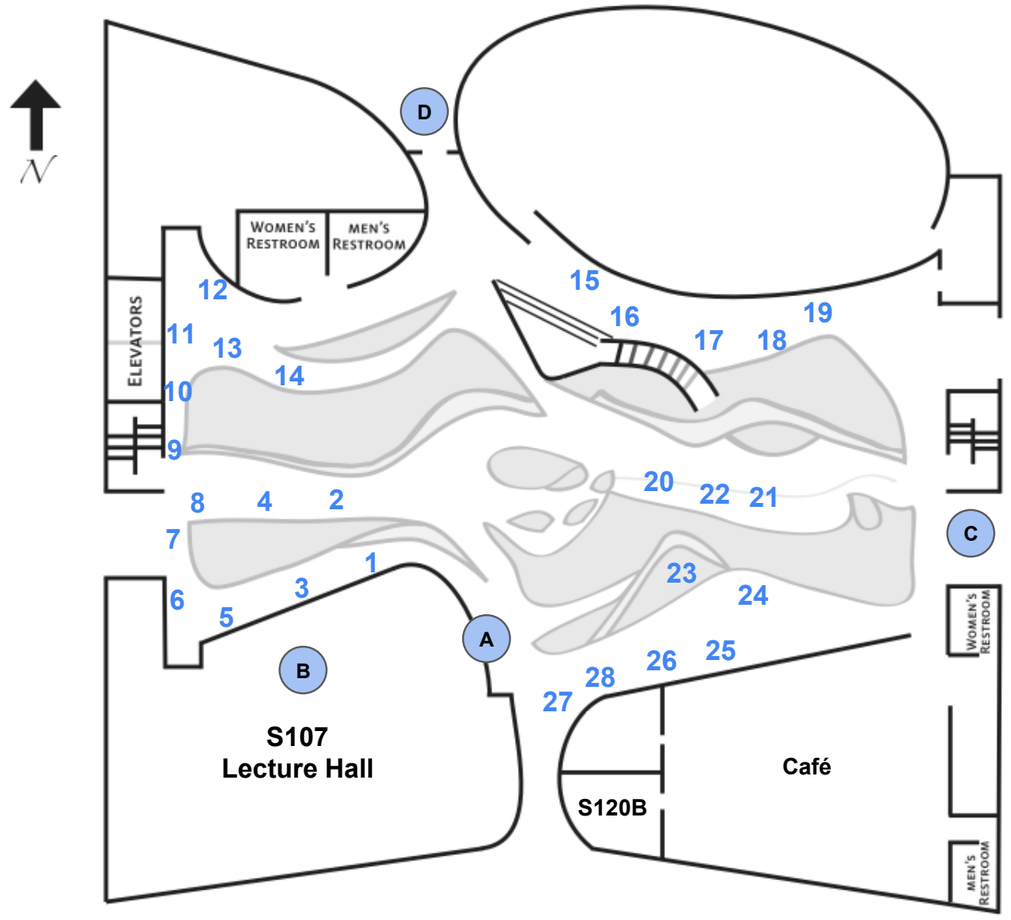
2:45pm Zain Alqattan

Heavy Metal, Metalloids Inventories and Lead Isotopic Composition of a Post Wildfire and Flooding in Mining Towns, Arizona

Lead pollution is ubiquitous in our society and continues to be a lingering problem, particularly for environmental justice (EJ)/marginalized communities. The extent of wildfire and flooding is changing rapidly in the United States and increasing the risk of lead and other heavy metals/metalloids exposure. Natural disasters burdens can be magnified in mining towns where the possibility of (re)mobilizing and releasing contaminants becomes a growing concern to the local communities. Soil samples from three depths and indoor and outdoor dust were analyzed for total bioavailable concentration of heavy metals/metalloids. To understand and tease out the source of Pb, isotopic composition was analyzed to source track the origin of lead and the associated co-occurrence of heavy metals/metalloids in the non-residential and households' locations in mining districts in Arizona. An in-depth review of the literature was conducted to consolidate previously identified Pb source apportionment to evaluate and confirm the sources of lead in

Poster Presentation Map

- A: Food and Registration Tables
- B: Oral Session Locations
- C: 6th Street Garage Entrance
- D: Lowell Street Entrance



Poster Presentations

1 Hannah Reichman - Advised by Dr. Malak Tfaily

Linking Wetland Carbon Cycling to Soil Organic Matter Content

While covering only about 5% of Earth's surface, wetlands play a critical role in the carbon cycle, storing a significant portion (20-30%) of global soil carbon due to their anaerobic conditions. However, climate change poses a threat to these ecosystems and their ability to sequester carbon. Additionally, physical and chemical protections of different wetland soil types might influence how carbon is stored or released. This report investigates how carbon mineralization (decomposition) varies across different wetland soil types (mineral, mineral-organic, and organic) with varying organic matter content. Long-term incubation experiments reveal that soil type, rather than the specific soil fraction, is a key factor controlling carbon stabilization and microbial activity. As the results show, wetlands with higher organic matter content displayed a greater susceptibility to microbial breakdown. Furthermore, after 2 years and 7 months, we observed clear differences in final soil composition and overall microbial productivity across different soil types.

2 Kamila Murawska-Wlodarczyk - Advised by Dr. Alicja Babst-Kostecka

Strategies and compromises of metal tolerant drought resistant plant growing on metal contaminated tailings

Industrial and mining activities have significantly contaminated soils worldwide, making areas unfit for reuse or habitation. Mine tailings often have acidic pH, poor nutrient content, and low microbial biomass, with elevated metal levels toxic to many plants, challenging growth, and development. Phytoremediation, utilizing metal-tolerant or accumulating plants for metal(loid) stabilization, transformation, or extraction from contaminated sites, is gaining industrial traction. Therefore, understanding plant physiological and biochemical adaptation processes to stress is crucial. This study focuses on the halophyte Atriplex lentiformis, which tolerates high metal levels (Zn, Cd, As, and Pb). We investigated its reproductive strategies and metal homeostasis mechanisms in seeds using Synchrotron X-ray Fluorescence Microscopy (XFM) and tomography. Our findings show toxic metals mainly located in maternal tissues surrounding the seeds, with high zinc levels in embryos from polluted areas, indicating unique adaptation mechanisms. This research deepens our understanding of plant trace element cycling in disturbed ecosystems.

3 Shalini Kadinappulige - Advised by Dr. Mark L. Brusseau

Role of air-water interfacial area in retention and transport of PFAS.

Per- and Polyfluoroalkyl Substances (PFAS), are anthropogenic chemicals which have been used in industry and consumer products. Due to their characteristics such as persistence and mobility, they are now widely spread in the environment making a huge risk of exposure to human. One of the primary factors affecting the transport and fate of PFAS is the phase-transfer process. A probable retention process for PFAS is the adsorption to fluid-fluid interfaces, such as air-water, oil-water, and air-oil interfaces. PFAS adsorption at the air-water interface can be quantified by measuring the air-water interfacial area. Our study focuses on investigating two laboratory methods to measure air-water interfacial areas for soils with different physical and geochemical properties. The interfacial tracer test is one method, which involves the use of an interracially active tracer. The second method is based on measuring the soil-water characteristic and subsequent conversion to interfacial area.

4 Ghiwa Makke - Advised by Dr. Malak Tfaily

Exploring Belowground Dynamics of Microbial and Metabolic Responses to Climate Change Drivers at SPRUCE

Peatlands, covering only 3% of Earth's land surface, store a third of all terrestrial soil carbon, and are crucial for global carbon sequestration but their future role is uncertain. These extreme environments challenge organisms with low oxygen, acidity, and nutrient scarcity, influencing carbon cycling. While aerobic decomposition dominates above the water table, anaerobic processes prevail deeper down however further research is needed to understand peatlands' response to environmental change and its impact on the global carbon cycle. Here we analyzed samples along a depth gradient from the Spruce and Peatland Responses under Changing Environments (SPRUCE) experimental site. By using LC-MS/MS coupled with metagenomics analysis, our study revealed a strong depth stratification of both metabolic and microbial communities. Our findings suggest that carbon degradation in the soil is constrained by electron acceptor availability, driving a diverse range of anaerobic respiration processes fueled by organic matter within the soil.

5 Ruth Muir - Advised by Dr. Alicja Babst-Kostecka

From Sunlight to Soil: Agrivoltaic Impacts on Tepary Bean Development and Rhizospheric Microbial Communities

There is a critical need for sustainable agricultural practices in arid environments due to global warming and expanding desertification. Initiating and maintaining plant growth in arid regions is challenging because of limited soil moisture and excessive solar radiation. Agrivoltaic technology, which provides shade, mitigates heat- and drought-stress, and improves soil moisture retention, offers a promising solution. This study aimed to assess the performance of tepary beans (Phaseolus acutifolius) grown under solar panels compared to open-field conditions, examining plant development, yield, and plant-microbe interactions during one growing season. Tepary beans exhibited higher agricultural performance under solar panels, evidenced by multiple plant traits. Ongoing comparative analyses of the soil microbial diversity and abundance will elucidate potential synergistic relationships between soil health and plant productivity under agrivoltaics settings. This research highlights benefits of integrating agriculture with photovoltaic production to address environmental challenges in arid regions, offering hope for a more sustainable future through

6 Favianna Cubello - Advised by Katerina Dontsova

Detachment and Transport of Composition B particles during Overland Flow

Energetics used in military exercises can potentially contaminate ground and surface waters. Two studies were conducted to evaluate the movement of Composition B, a formulation that includes TNT (2,4,6-trinitrotoluene) and RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine) during overland flow. Rainfall simulations and rill erosion experiments were conducted under controlled conditions to examine all transport pathways. Composition B particles remaining on the soil surface were measured as well as energetics dissolved in runoff, in suspended sediment, and in infiltration. Greater concentrations of TNT than RDX were found dissolved in runoff due to its higher solubility and dissolution rates. We also found that particle transport in runoff increased with decrease in particle size. Relationships were found relating runoff and sediment yield to the transport of RDX and TNT. The results of these studies allow for improved prediction of Composition B transport in overland flow and its contamination potential

Poster Presentations Continued

7 Christian Barra - Advised by Dr. Craig Rasmussen

Wildfires effects on soil physical, chemical, and hydraulic properties in the Santa Catalina Mountains, Arizona, USA

Wildfires can lead to significant changes in the soil properties, affecting ecosystem processes. Trajectories of ecosystem responses and recovery remain poorly constrained, particularly as fire features shift with changing climate. This study addresses that knowledge gap and quantifies post-wildfire change in soil physicochemical properties across a matrix of fire severity in the Santa Catalina Mountains, Arizona. We found that pH and concentrations of extractable nitrate and ammonium increased significantly following fires due to the release of nitrogen and H+ during combustion. Carbon content exhibited no clear trend and no significant changes. Soil hydraulic conductivity (Ksat) evidenced significant variation relative to fire severity, whereas sorptivity (S) showed changes depending on the fire severity and vegetation type. Regression modeling indicated that either S and Ksat were strongly and positively correlated with lack of hydrophobicity and negatively correlated with increasing C:N. Findings reveal a complex response of soil properties to wildfire and ecosystem

8 Santiago Valencia - Advised by Dr. Julia K. Green

Effects of intra-annual precipitation variability on global tropical forest and savanna distribution

Forests and savannas are the most extensive tropical ecosystems with ecological, climatic, and biogeochemical implications at the global scale. Their spatial distribution has been mainly related to precipitation patterns with forests dominating in regions with high precipitation, and savannas dominating where precipitation is low. However, both vegetation types occur at intermediate mean annual precipitation levels. Based on remote-sensing data, we analyze the interactive effect of soil properties, fire occurrence, and precipitation at multiple temporal scales on global tropical forests and savanna distribution. Specifically, we examine how the duration of wet and dry spell (i.e., consecutive number of days with/without precipitation) during the wet and dry season could provide a better explanation of ecosystem distribution compared to aggregated precipitation metrics (e.g., seasonal and annual). Our results can provide new insights into how water availability variability drives the current and future distribution of forests and savannas.

9 Mekayla Crawford - Advised by Dr. Malak Tfaily

Elucidating the Spatial Metabolome of Invasive and Native Grass Roots Using MALDI-MSI

Elucidating plant invasion mechanisms and developing enhanced management strategies requires advancing metabolite characterization techniques. Here we used matrix assisted laser desorption/ionization-mass spectrometry imaging (MALDI-MSI) to visualize and compare root metabolites between invasive Lehmann lovegrass and native Arizona cottontop grasses. MALDI-MSI revealed Lehmann lovegrass maintained higher levels of nitrogen carriers like asparagine and allantoin, exhibiting flexible acquisition from both plant and microbial sources across environments. In contrast, Arizona cottontop relied heavily on microbially-produced allantoin regardless of environment, overinvesting in exudates. We propose Lehmann's flexible nitrogen and exudate strategies improve resource use efficiency and invasiveness across habitats. Integrating metabolite profiles provides key insights into exotic species' invasive potential over native plants. Advancing techniques like MALDI-MSI is critical for elucidating invasion mechanisms to inform improved management strategies.

10 Anu Sethuraman - Advised by Dr. Joseph Hoover

Cultivating water resilience with an Indigenous community in the Southwestern US

Historical uranium mining within the Navajo Nation (NN) left behind 523 abandoned mines, potentially exposing residents to harmful trace metals. Simultaneously, the region contains a multi-layered aquifer system with naturally occurring levels of trace metals such as uranium and arsenic. In a community within NN located downstream of a legacy mine, previous research is inconclusive about mining-related contamination of groundwater. As such, concerns remain for many residents who rely on this water for many household purposes, making monitoring of wells in the region essential. For this project, groundwater samples were collected and analyzed for trace metals, major cations, and major anions. Future sampling will be combined with stable isotope and radionuclide analysis. With water security as a motivating factor, these data will be used to better understand how water quality is changing and affected by natural and anthropogenic sources of trace metals in the area.

11 Andréa Martinez - Advised by Dr. Julie Neilson, Dr. Alicja Babst-Kostecka

Relative abundance of nutrient cycling genes as a metric of soil health during mine site reclamation

When mines close, they leave behind waste and an altered, degraded landscape. Revegetation is crucial for reducing harmful exposures, preventing erosion, and restoring ecosystem services. Successful revegetation requires a coupling of aboveground and belowground health, with plant establishment often correlating with increases in soil microbial biomass. This work aims to determine if the increase in microbial biomass is associated with a rise in nutrient-cycling capacity. qPCR was used to evaluate relative gene abundances, targeting nitrogen cycling (amoA, ureC), fungal abundance (18S), and bacterial abundance (16S) genes in soils from a revegetated mine site. To ensure compatibility, temperature cycles were optimized for amplification of all target genes on the same qPCR plate. Nutrient-cycling capacity was quantified as a ratio of the nutrient-cycling genes (18S, amoA, ureC) to bacterial abundance (16S). This will be used as a metric of soil health development and enhanced ecosystem services during mine site reclamation.

12 Caitlin Tribelhorn - Advised by Dr. Paul Carini

Enrichments of Anaerobic Archaea from Estuarine Intertidal Sediments

Novel anaerobic archaea dominate marine sediments worldwide, including those that gave rise to eukaryotes. To describe this novel diversity, we investigated the microbial community structure and established enrichment cultures from estuarine intertidal sediments of Yaquina Bay, Oregon. Our aim is to enrich and isolate Asgard archaea in anaerobic culture media to examine their roles in sediment nutrient cycling. Sediment cores (30 cm deep) were collected from five sites in June and July 2023, and fractioned for culture-based and microbiome analyses. Enrichment cultures were initiated by adding sediment to the media supplemented with organic carbon substrates. Cultures were monitored for growth using qPCR with Asgard-specific primers and flow cytometry. Microbiome analysis of each site was performed using general 16S rRNA gene primers and revealed the relative distribution of Asgard in the enrichments. This work contributes to expanding the knowledge of the phylogenetic diversity of archaea, their syntrophic relationships, and subsurface microbial

Poster Presentations Continued

13 Simran Singh - Advised by Dr. Luisa Ikner

Methods Development for Testing Treated Wastewater for Viruses Leading to Potable Reuse.

Water scarcity is a major concern in arid regions, and direct potable reuse of treated wastewater provides a viable option for mitigation. Conventional wastewater treatment may not remove all pathogens, and without an environmental buffer advanced treatment is required to ensure potability. Viruses are of particular concern due to their small size, low infectious dose, and disinfection resistance. This project proposes to create a more rapid and sensitive method to detect and quantify viruses following advanced treatment. Tangential flow filtration will be optimized and used to concentrate viruses which are present at low concentrations in treated water. The concentrates will be assayed using cell culture and digital PCR techniques to quantify infectious viruses and total nucleic acids, respectively. The wastewater virome will also be characterized to identify novel indicators of treatment performance using bioinformatics. The results of this project will inform decision-making regarding advanced water treatment for direct potable reuse.

14 Vidula Lokugama - Advised by Dr. Raina M. Maier and Dr. David E. Hogan

Innovative Remediation of Uranium-Contaminated Groundwater A Study on Selective Recovery Using Bioinspired Glycolipid Surfactants

Uranium contamination of groundwater above the drinking water standard (30 ug/L) occurs from both natural sources and mining activities. A variety of remediation approaches for uranium-contaminated groundwater have been developed, each with associated advantages and disadvantages related to ease of operation, cost, and production of waste. Here we discuss a novel method that employs a resin functionalized with bioinspired glycolipid surfactants. These glycolipids are highly selective for uranium, can be synthesized using green chemistry, and are reusable. We have previously shown the selective binding of several glycolipids with uranium. Here we present a method that can recover and concentrate uranium from dilute groundwater samples using a glycolipid that is hydrophobically bound to a resin.

15 Jasmine Miranda - Advised by Dr. Luisa Ikner

Seasonal Variation in Relative Abundance in Yuma, Arizona

Yuma, Arizona, is a vital agricultural center, producing 91% of North America's winter leafy greens. The influx of approximately 10,000 agriculture workers during peak season heightens health risks for the U.S.-Mexico border community. This study tracks viral dynamics in wastewater during peak migratory periods, aiming to identify respiratory viruses and their expected shift in abundance. Wastewater samples from municipal treatment plants were analyzed using Illumina's sequencing technology, identifying the presence of respiratory viruses. Samples were collected over two growing seasons (2023-2024) between November and February, with two-month buffer periods. Preliminary data reveals trends during peak agriculture seasons, suggesting shifts marked by seasonal worker influx. Further investigation will identify viral strains, pinpointing health risks faced by seasonal migrant workers. Yuma County's case study offers a worldwide model for safeguarding seasonal workers in agriculturally significant regions navigating the intersection of infectious diseases, public health, and agriculture.

16 Kendra Wissinger - Advised by Dr. Raina Maier and Dr. David Hogan

Rhamnolipid Removal of Rare Earth Elements from Contaminated Mining Wastewater

Rare earth elements are vital in the exponential growth of electronics. The reliance of the United States on foreign nations for rare earth element importation increases accordingly with technological advancements. During the mining process, significant amounts of rare earth elements are found in wastewater runoff. Research suggests that reclamation processes have the potential to recover enough rare earth elements to significantly decrease dependence on other countries. The use of surfactants has shown to successfully remove significant percentages of metals out of contaminated water. Surfactants are specialized molecules that contain a hydrophilic head and hydrophobic tail. Polar and nonpolar sites work together to effectively create a cage that can trap and remove metals, returning the water to FDA approved drinking standards. The success of removal is being investigated with rhamnolipid surfactants and various rare earth elements.

17 Garrett Hagen - Advised by Dr. Craig Rasmussen

Analyzing soil nutrient change at Red Rock Agricultural Center after 15 years of agricultural management

The goal of this study is to analyze soil property change at Red Rock Agricultural Center after 15 years of agricultural management by comparing archive and newly collected soil samples. The Red Rock Agricultural Center is located 30 miles northwest of Tucson and has a hyperthermic and aridic soil temperature and moisture regime. The archive samples were collected in 2005 and the new samples were collected in the spring of 2023. Prior to site development, the RRAC was managed as an open range and was occupied by native Sonoran Desert scrub. The new samples were collected at the same locations as the archive sample sites and spanned three treatments including long-term fallow, alfalfa fields, and native soils. It was hypothesized that tillage, irrigation, and fertilizer application significantly altered soil chemical and physical properties. This study will compare the new and archived data to quantify significant changes in soil properties.

18 Caroline Shults - Advised by Kathleen Landeen and Katrina Teer

Derelict and End-of-Life Fishing Gear Recycling Processes, Associated Difficulties, Recommended Methods, Related Expenditures, and Why it is Important

This research addresses each aspect of the industrial fishnet recycling process and gives an overview of related information. Some initial understanding of the scale of the issue and how it is dealt with is described as there are many companies and initiatives designed to help reduce the effects of fishing net waste. A materials analysis and differentiation between thermal and mechanical processing steps was performed as well as a comprehensive list of what can and cannot be recycled. Conclusions about which process is more recommended and an overview of the importance was drafted to provide adaptable information for future endeavors. Keep in mind that the existing literature surrounding this subject is minimal and much of the information referenced is from 2018 trials conducted by MARELITT Baltic with few other companies formally researching this subject.

19 Alexia Vance - Advised by Dr. Kelly Reynolds

Bathroom Viral and Bacterial Contamination via Hand-Drying Methods

Hand washing and drying are crucial for preventing microbial spread, yet the impact of hand-drying methods on bathroom contamination remains uncertain. This study evaluated the spread of Phi-X174 bacteriophage and Escherichia coli during hand drying via three methods: unrecessed HEPA dryer, recessed HEPA dryer, and paper towels. Participants washed their hands that were contaminated with organisms, followed by drying. Air and surface samples were collected. Hand dryers show low contamination (undetectable to 2.12 cfu/mL) compared to paper towels. The door handle exhibited high contamination with paper towels (22.50 cfu/mL for E. coli, 471.67 pfu/mL for Phi-X174). However, there was no significant difference between paper towels and HEPA dryers.

Poster Presentations Continued

20 Ma'in Alghzawi - Advised by Dr. Jon Chorover

Climate Controls on Metal(loid)s Bioaccessibility in Mine Tailings

The annual mass production of waste mine tialings is comparable to the mass movement from natural weatehring of topsoil, and many contain elevated levels of toxic metal(loid)s including arsneic (As). Studies have shown the impact of oxidative weathering on As speciation and bioaccessibility; however, the impact of climate, which drives weathering, has not been studied. An in vitro bioaccessibility assay (IVBA) was used to evaluate potential As exposures from tailings as a function of climate-controlled speciation and bioaccessibility. We hypothesized that As would be least bioaccessible when adsorbed to the surfaces secondary Fe (oxhydr)oxides such as goethite. Tailings particles were introduced into biochemical fluids that simulate the human oxic, acidic stomach and the anoxic, circumneutral intestinal fluids. Metal(loid) dissolution was found to be controlled by mineralogy, simulant fluid characteristics, and incubation time. The links between As speciation and bioaccessibility will be helpful in creating a risk prediction tool that will

21 Jing Huang - Advised by Dr. Julia K. Green

Evergreen needleleaf forest energy, water, and carbon cycle process response to extreme drought

Evergreen needleleaf forests cover four percent of the land surface and exert profound influences on carbon and water cycling. With the increasing frequency of extreme drought events worldwide, research has shown a trend of increased evapotranspiration at a global scale under drought conditions. However, the responses of energy, carbon, and water fluxes within ecosystems under extreme drought remain unclear. Here we investigate the responses of energy, water, and carbon fluxes to extreme drought in four European evergreen needleleaf forest ecosystems. The results indicated significant reductions in latent heat flux, sensible heat flux, and soil heat flux under extreme drought, decreasing by 29%, 14%, and 62%, respectively. Gross primary productivity and ecosystem respiration were also suppressed, decreasing by 43%, and 37%, respectively. In terms of energy and water utilization, energy use efficiency declined by 12%, and water use efficiency increased by 5%. These findings could provide insight into the resilience of

22 Richelle Thomas - Advised by Dr. Jean McLain and Dr. Robert Root

Uptake of uranium and arsenic in Salvia, Thelesperma, and Helianthus: A study to identify potential risks of heavy metal(loid) uptake into medicinal plants utilized by Indigenous peoples.

The legacy of resource extraction on Native lands in the Southwest has left an estimated 500 unremediated mine sites, and contamination may pose a risk to Indigenous peoples through the utilization of medicinal plants. Not much is known about heavy metal(loid) uptake and exposure from use of these sacred plants. This study will measure the uptake of uranium and arsenic in soils and plant tissues to predict potential harm to human health. Field data shows that Salvia grown in soil with 0.79 µg g-1 U and 7.58 µg g-1 As has 0.01 µg g-1 of U in plant tissue, and 0.09 µg g-1 As in plant tissue. Greenhouse experiments showed no growth in 500 ppm As, 5% upper biomass growth in 100 ppm As compared to the control, and 50-75% upper biomass growth at 20 ppm As compared to the control. Study findings will be shared with the Navajo Nation.

23 Melissa Jacquez - Advised by Dr. Mónica Ramírez-Andreotta

Cultivating Engagement, Empowering Change: Inquiry Environmental Health Education in the Arizona Copper Corridor

Building trust and engagement is a crucial foundation for addressing environmental injustices (EJ). Building upon a decade of community-engaged research/co-created environmental health science, the Integrated Environmental Science and Human Risk Laboratory at the University of Arizona is working alongside communities that neighbor resource extraction activities, to create a Science, Technology, Engineering, Arts, and Math (STEAM) educational model that addresses community-identified EJ and public health issues. To understand the communities' initial environmental health knowledge and STEAM education assets/needs, formative evaluation efforts - listening sessions (N=2) and a teacher survey (N=23) were conducted with community members/educators living in the following AZ's Copper Corridor towns/cities: Hayden, Winkelman, Superior, Globe, Miami, and Casa Grande. Via a qualitative inductive analysis, the results identified the following key areas of interest: (1) sources of exposure affecting human health, (2) food sovereignty, (3) localized knowledge, and (4) mining impacts. The community expressed a desire for hands-on activities to

24 Susan D. Perez - Advised by Dr. Raina M. Maier and Dr. David E. Hogan

Factors controlling removal of uranium from groundwater with glycolipids and ion flotation: a path to achieving compliance

Uranium is present in many mining-influenced waters throughout the arid southwest, and remediation of these waters may be necessary to meet future water demands. We have previously shown ion flotation as an effective technology for the removal of uranium from groundwater using environmentally-friendly glycolipids (sugar-based surfactants) under narrow solution conditions. In this study, the physicochemical characteristics of uranium-contaminated solutions and process conditions are further investigated to identify operational parameters—such as glycolipid molecular structure and solution constituents/chemistry—that control the efficacy of uranium remediation from mining-influence waters using glycolipid-based ion flotation.

25 Lois Polashenski - Advised by Dr. Mónica D. Ramírez-Andreotta

Development of Wastewater-Based Epidemiology Methods for Detection of Candida auris

First utilized in 2001 to detect poliovirus, wastewater-based epidemiology (WBE) monitors wastewater for a variety of pathogens that may be introduced from a given population through viral shedding (Hovi et al. 2001). Its utilization for detection of SARS-CoV-2 in recent years has made it a popular monitoring tool for community health (Betancourt et al., 2021). Moving forward, WBE can be implemented to monitor additional targets of concern. Candida auris, a yeast with resistance to common anti-fungal medications, often presents as skin or blood infections in hospitals and nursing home patients (Chowdhary et al., 2023). Due to the transmissibility and increasing prevalence in settings with at-risk patients, Candida auris is a prime target for this type of surveillance. This study outlines the development of methodology to detect Candida auris using wastewater-based epidemiology.

Poster Presentations Continued

26 Renata Martin - Advised by Dr. Laura Meredith and Dr. Vanessa Buzzard

Optimizing Tree Establishment in Urban Arid Environments: A Comparative Study of Impacts of Water Management Practices on Soil

Residential potable water is used for landscape irrigation in Arizona's metropolitan area. Extreme drought conditions coupled with water scarcity presents a challenge for irrigating trees during their establishment years. To address these challenges, innovative tree watering techniques are needed to maintain soil moisture effectively and promote tree establishment. This presentation introduces an ongoing study for a controlled experiment of 80 saplings planted at the University of Arizona Campus Agriculture Center. We tested five water saving techniques, specifically hydrogel (cellulose and plastic-based), organic mulch, rain basin, and conventional drip irrigation for four Arizona native and drought-adaptive tree species (Quercus fusiformis, Olneya tesota, Celtis pallida, Chilopsis linearis). We measured soil properties and plant health metrics of the 80 saplings to assess impacts of these water saving techniques.We hypothesize that hydrogel treatments maintain higher moisture levels than other types of treatments.

27 Kielah Dyer - Advised by Dr. Katerina Dontsova

Investigating Weathering as Influenced by Different Genotypes of Alfalfa

This project investigates the effect of different alfalfa genotypes on the weathering of basalt substrate and carbon sequestration. Its primary goal is to identify the most suitable alfalfa genotypes for optimized growth and carbon sequestration. In greenhouse pot experiments, basalt was sterilized or inoculated with soil microbes to assess the microbial impact. The plants were grown under three different soil moisture conditions to analyze how water content affects growth patterns. At experiment completion, pot pore water was flushed and analyzed for cation and anion, organic and inorganic carbon concentrations, pH, and other factors to assess the impact of plants and microbiota on weathering and carbon sequestration and feedback to plant health. Accumulation of solid C and N in basalt with and without plants and/or microorganisms was also quantified. This study provides valuable insight into how plants react to stated soil conditions and the potential use of basalt in degraded soils.

28 Camille Tinerella - Advised by Katrina Teer

Specific Leaf Area Effect on Drought Sensitivity of Desert Species

Rapid warming of the Earth has intensified precipitation variability, particularly in desert regions. Variations in precipitation has caused alterations to desert species' responses to drought. Understanding these changes is vital for better predictions of future changes in vegetation. We analyzed species' responses to drought using 100 years of precipitation and performance data. We then studied characteristics that could be related to this variation in drought response. Specific leaf area refers to the balance between the quality and cost of the leaves produced. We hypothesized that drought sensitivity is related to specific leaf area, as drought conditions may have effects on plant growth and performance. Our findings indicate that specific leaf area may not reliably predict plant performance under intensified drought conditions. This alludes to the complexities of plant's response to drought highlighting the need for further research into the underlying mechanisms and predictors of vegetation dynamics in desert ecosystems

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We respectfully acknowledge the University of Arizona is on the land and territories of Indigenous peoples. Today, Arizona is home to 22 federally recognized tribes, with Tucson being home to the O'odham and the Yaqui. Committed to diversity and inclusion, the University strives to build sustainable relationships with sovereign Native Nations and Indigenous communities through education offerings, partnerships, and community service.