2023 CZNET REU

VIRTUAL SYMPOSIUM PROGRAM

August 4, 2023

Virtual

Agenda

1:00 PM	Welcome and Introductions
1:10 PM	Research presentations and Q&A in Breakout Rooms Presenters*: Jose Montoya Lariza Avila Alyssa Luna Suly Morel Mia Day
2:10 PM	Break
2:20 PM	Research presentations and Q&A in Breakout Rooms Presenters*: Anne Cook Victor Barrientos Michaela Brossman Tristina Ting Kat Raiano *in presentation order
3:20 PM	Closing

Event information

Code of Conduct

- Attendees at all events hosted by CUAHSI are required to abide by our Code of Conduct.
- Visit our website for more information.

Posters

- Presenters will provide an overview of their research for all attendees in the main Zoom room.
- Presenters will answer questions in breakout rooms.
- Attendees can see the presenter's posters here.

Event rules

- Hold all questions until the breakout rooms.
  - If you would like to show support for a presenter, you can use reactions (found on the bottom bar of your Zoom screen) after a presentation.
- You can also put questions in the Q&A as they come up.
- Once the breakout rooms are open, participants can move from one room to the other to meet with presenters.
  - We encourage you to visit all breakout rooms.
- The presentations in the main Zoom room will be recorded.

Presenters

Lariza Avila

Victor Barrientos

Michaela Brossman

Anne Cook

Mia Day

Alyssa Luna

Jose Montoya

Suly Morel

Kat Raiano

Tristina Ting

Abstracts

Phosphorus Availability Shifts across a Desert Soil Chronosequence

Lariza I. Avila, Kristopher R. Torres, Dylan, J. Stover, Jennie R. McLaren

The Chihuahuan desert is a biodiverse landscape, but organisms are limited by both water and nutrients. Desert nutrient limitation studies have primarily focused on nitrogen (N) as a potential limiting nutrient; however, recent studies show that phosphorus (P) also has the potential to be limiting. One possible cause of P limitation in dryland systems is the abundance of precipitated carbonates. In the Chihuahuan Desert, the calcium carbonate-rich soil binds to P. We predicted that as soil ages and the carbonate content increases, there would also be a shift in P availability for plants and microbes. Using a biologically based phosphorus (BBP) extraction method, we ran four parallel extractions emulating common plant and microbe P acquisition mechanisms across a soil chronosequence at the Jornada Experimental Range in the Chihuahuan Desert. Each extractant characterizes a pool of bio-available P: soluble, labile, organic, and occluded. For comparison, we also used standard methods of P extraction, Olsen-P, and potassium sulfate. We found that consistent with other ecosystems, many forms of bio-available P decreased with soil age – hydrochloric acid extractable P steadily decreased with soil age, Olsen-P decreased for the first 2,200 years of soil development, and potassium sulfate extractable P decreased after 10,000 to 15,000 years. Similar to Olsen-P, calcium chloride extractable P decreased in the first years of soil development before stabilizing. The citric acid and enzyme extractable pools deviate from expected trends. Enzyme extractable P increases after 8,000 years of soil development before decreasing around 15-25,000 years. Citric acid extractable P, however, decreases after 2,200-7000 years, returning to original levels upon reaching 8000-15000 years old. While we expect a decrease in P levels as the soil ages, the deviation from the models seen in biological pools may be due to the increase in P sorption as carbonate content increases as the soil ages. Since phosphorus is a non-renewable resource, we must understand the shift in P over time and the impact on plants and microbes. Recognizing the relationship between P availability, carbonates, and age will provide a greater understanding of phosphorus limitation in the drylands.

Abstracts

Chemical Dynamics of Soils in the Urban Critical Zone: Metal Contamination Surrounding the Pennypack Creek Watershed of Philadelphia, Pennsylvania

Victor I. Barrientos, Daniel J. Bain

Human activity on watersheds like filling in a stream channel or building up the landscape can have a lasting effect on the chemistry of soils by introducing metal contamination and altering the natural flow of water. In Willow Grove, Pennsylvania, the development of an area beside the Pennypack Creek Watershed has been well recorded throughout the last sixty years with aerial photography. These images reveal a secondary channel and landscape that has been filled in from 1985 to 1990. Besides lead which is expected in most urban soils, there is a lack of data for metal contamination as soil chemistry for this site has not been documented before. This study addresses how fill and flood influence from human activities can control chemical patterns in a suburban riparian critical zone. Five soil cores were collected at this site and mapped on ArcGIS for comparison with aerial photography to get an idea of how undisturbed each soil sample would be from human activity. The location for the first core was originally chosen because of its distance from an artificial hill and its proximity to a tree, but was later found to be in the area where the land had been filled. After being profiled, 20 cut samples from these cores were prepared for modified sequential extraction and analysis through inductively coupled plasma mass spectrometry (ICP-MS). Data results from exchangeable sequential extraction produced a calcium/strontium ratio consistent with that of cement and sheetrock with these metals being highest in cores #2 and #5. Core #3 had the highest levels of lead, copper, zinc and significant levels of arsenic. Core #4 had the highest level of cadmium and significant levels of manganese. Core #1 relatively had the lowest levels of metal contamination with the exception of manganese being significantly high still. These results ultimately reveal the extent of metal contamination in soils surrounding the watershed as a consequence of human construction and development.

Abstracts

Transport and Storage of Sediment Supplied by Road and Urban Construction in the Anacostia River

Michaela S. Brossman, Karen L. Prestegaard, John. A. Harris

The NW Anacostia River, a suburban watershed near D.C. has experienced a doubling of bankfull discharge, recent major road and suburban construction, and streambank stabilization projects. The purpose of this study is to investigate the impact of these activities on a 2.11 km gauged reach of river. The position of each bank was mapped along the reach on 2002 and 2022 images, and used to determine erosion/deposition areas and rates. 34 individual gravel bar areas were mapped on successive images between 2015 and 2022. We conducted field work to measure bar surface grain sizes and sample subsurface and overbank sediment for sieve analyses. The channel change analysis indicated balanced erosion and deposition on the south bank (which had bank stabilization structures) but erosion rates 2x that of deposition rates on the north bank, suggesting that S. bank stabilization shifted erosion to the opposite bank. Bar surface median grain size ranged from 18 to 35 mm; D84 grain size was 1.5x D50, but there was no correlation between surface and subsurface grain sizes. Bars with larger surface areas and adjacent areas of bank erosion had smaller surface grain sizes than coarser bars. Rouse calculations of sediment suspension for bankfull conditions were consistent with field data; 0.125-0.18 mm was deposited on bank tops, but 2 mm and coarser sediment was retained in the bed. The percentage of sand (<2 mm) in the subsurface ranged from 25-53%. Bed mobility data suggest that bar sediment moved several times per year, but without systematic increases in bar size. These data indicate that recently supplied sand is primarily stored in the bed subsurface, increasing bed mobility, with finer sand formed levee deposits that raised bank heights. Changes in bank height and net bank erosion contributed to an increase in bankfull channel capacity.

Abstracts

Sediment Dynamics in an Intensively Managed Agricultural Watershed

Anne Cook, Bruce Rhoads, Chelsy Salas

Sediment is the leading cause of pollution of freshwater systems in the United States. Despite extensive past research on sediment dynamics of rivers, temporal and spatial variations in sediment loads of rivers in intensively managed agricultural landscapes of the midwestern United States remain poorly understood, hindering management aimed at reducing excessive amounts of sediment in rivers. This research characterizes a midwestern agricultural watershed: 1) temporal variation in long-term sediment fluxes over several decades, 2) short-term event-based relationships between discharge and concentration, and 3) spatial and temporal variations in sediment source contributions to suspended sediment flux during discrete hydrologic events. The study area for the research is the upper Sangamon River Basin in East Central Illinois - a low-relief watershed in which nearly 90% of the total watershed area is devoted to agricultural land use. Data for the decadal analysis of temporal variation in sediment flux have been collected weekly since 1980 by the Illinois State Water Survey as part of its benchmark sediment monitoring program. Sediment data for discrete hydrological events have been collected since 2015 using an automatic pump sampler. Suspended sediment samples collected for hydrologic events in the summer 2023 have produced data for sediment-source tracing based on 7Be. Preliminary results show that sediment concentrations are highly variable over time, but that distinct seasonal differences in the relation between sediment load and discharge can be identified. Future work will focus on efforts to distinguish between different sediment sources using the 7Be tracing results.

Abstracts

Spatial Variability and Chemical Composition of Dust Deposition in Uinta Mountan Snowpack

Mia Day, Greg Carling, Kendra Caskey

Dust deposition to mountain snowpack is increasing due to climate change and land use changes, altering the biogeochemistry and hydrological regime of alpine systems. Annual melting of snowpack in the Uinta Mountains of northeast Utah is the state's primary water resource, making it critical to understand the composition and amount of dust reaching the high elevation snowpack and downstream effects on runoff and water chemistry. Understanding the spatial variability of dust deposition and dust composition may indicate locations that are at higher risk of being impacted by dust inputs as well as inform the data collection methods of future projects in ensuring sampling locations are representative of deposited dust across the field site. Dust composition may indicate potential dust sources (i.e. bedrock sources if dust composition aligns with surficial geology versus long-distance wind transport) and reveal potential sources of down-system water contamination if heavy metals were found in snowpack dust samples, for example. To test this, we collected 60 samples at Bald Mountain Pass in the Uinta Mountains during June 2023, with an equal number of samples on the windward, leeward, and top of the ridge. We expected dust deposition to vary spatially across the ridge, with the highest deposition on the windward side of the ridge, and expected chemical composition to be consistent across the ridge. Snow samples were collected at each of three locations (windward, leeward, ridge) in transects using 2-inch diameter tubes. Samples were melted, filtered, dried, and weighed for dust content and major oxide and trace element content are being determined using Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES). We found no statistically significant difference ($p<0.05$; one-way ANOVA) in dust deposition flux by mass across the three sampling locations with an average of 21.7 mg (± 0.56 mg, standard error) on the leeward side, 17.1 mg (± 0.47 mg) at the ridge, and 20.6 mg (± 0.42 mg) on the windward side, which refuted our hypothesis. Knowing that dust deposition does not vary significantly across the mountain ridge area informs future researchers both in terms of selecting sampling locations as well as eliminating potential confounding variables as location across the ridge was found to have no impact on dust mass.

Abstracts

Persistence of Megafire Impacts on Dissolved Organic Matter Optical Properties and Reactivity

Alyssa Luna, Benjamin W. Abbott

Climate change has caused a dramatic increase in wildfire extent, severity, and frequency in many regions, including the southwestern US. These severe wildfires, also referred to as megafires, can have significant impacts on the environment. Reactive organic matter released following wildfire is especially problematic, with the potential to interfere with and degrade drinking water treatment sources, create anoxia in streams and rivers, and affect increase nutrient availability, potentially causing eutrophication. Wildfire directly affects dissolved organic matter (DOM) in streams by removing vegetation and transforming soil organic matter during combustion, and indirectly by increasing algal productivity in streams where riparian vegetation was burned. Depending on the dominant source of DOM (terrestrial versus aquatic), wildfire has the potential to increase or decrease DOM reactivity. To assess the effect of a megafire on DOM reactivity, Wwe collected water samples over five years from ~60 sites in central Utah, half of which were impacted by a megafire in 2018. We analyzed the samples for DOM concentration and optical properties using a spectrophotometer and scanning fluorometer. According to the results, DOM concentration increased substantially immediately after the fire, but returned to pre-burn levels within one year. DOM bioreactivity and photoreactivity also increased during the first year following burn. OurWe interpretation this that the rapid return of DOM concentration and quality following a large megafire as an indication of suggests a relatively high resilience to this type of disturbance with implications for both society and ecosystem response to wildfires.

Abstracts

Do Snowmelt Driven Differences in Stream Discharge Control Surface water-groundwater Interaction in an Alpine Stream?

Jose Montoya, Kenny Swift Bird, Kamini Singha

In every river there is a zone of interaction with the subsurface known as the hyporheic zone. The hyporheic zone mediates surfacewater – groundwater exchange and these interactions are critical for nutrient processing, biodiversity, redox reactions, and recharge. We explore how hyporheic exchange is controlled by snowmelt runoff in alpine streams in Crested Butte, CO and Silverton, CO during the 2023 record year of snowmelt and discharge in the Colorado Rocky Mountains. We hypothesize that a there is a "Goldilocks zone" where there is the most hyporheic exchange with moderate discharge, and that at rates too high or too low that exchange will decrease, which is supported by the definition of the Damkohler number. To test this hypothesis, we conducted in-stream salt tracer tests and analyzed their breakthrough curves using temporal moments and transient storage modeling (OTIS). We compare our results to tests conducted under varying flow conditions in 2022. We expect to find that medium flow (0.09cms in July) has the most hyporheic exchange compared to tests at other times of season (0.54cms in June and 0.04cms in August).

Abstracts

How much riverflow is needed to rescue Great Salt Lake?

Suly Morel, Ben Abbott

Saline lakes contain half of global lake water and represent keystone ecosystems in semiarid and arid environments. One of the challenges of protecting saline lakes is their sensitivity to small changes in river inflow. Because the amount of river flow needed to maintain or increase lake levels is often not known, nearly all the Earth's large saline lakes are in decline, primarily because of irrigated agriculture. For Great Salt Lake, the largest saline lake in North America, there is active controversy about what the target river flow minimum should be. We analyzed historical river flow and lake level data on excel to estimate Great Salt Lake's equilibrium water flow: the amount of river flow needed to maintain annual average elevation. To estimate long-term and modern flow requirements, we combined observed lake elevation since 1850 and river flow since 1981 with dendrochronology (tree-ring reconstruction data) records since 1500. Despite substantial climatic variability, since 1981, there has been a persistent equilibrium flow between 2.0 and 2.4 million acre-feet per year (2.4 to 2.88 km3/yr). The annual timing of the maximum and minimum lake levels is strongly associated with annual river flow. These results suggest that approximately one million acre-feet of additional water is needed annually, representing 30-50% of the mean consumptive water use in the watershed. This highlights the challenge of attaining sustainable water use in the Great Salt Lake watershed but also provides a specific conservation target, which is currently lacking from the policy and public discourse.

Abstracts

Effect of Saltwater Marsh Migration on Soil Microbial Respiration as a Result of Sea Level Rise on the Delmarva Peninsula

Kat Raiano, Nate Spicer, Kate Tully, Brian Moyer

As sea levels rise, saltmarshes on the Delmarva Peninsula have crept inland due to saltwater intrusion, replacing agricultural crops such as corn (Zea mays). As a result, native salt marshes are migrating onto farmland and altering plant communities and soil chemistry. Saltmarshes play a significant role in the carbon cycle, acting as a carbon sink due to their anoxic conditions that slow organic matter decomposition rates and shape soil microbiota. Marsh plant communities form zones primarily governed by elevation. With sea level rise these communities within the marsh will shift upland. It is not fully understood how the transition of marsh plants upland will impact the soil microbial respiration in the new marsh, specifically their interactions with new organic matter inputs. However, we expected to see larger carbon dioxide and methane fluxes from agricultural fields transitioning to salt marshes than from a change of one marsh zone to another. We conducted a bottle incubation with organic matter and soils from 4 plants: Spartina alterniflora, Spartina patens, Phragmites australis, and corn, representing different marsh zones increasing in elevation. We added organic matter from each plant to a bottle with the soil from that plant's zone and another bottle with the soil from the zone it will migrate to. We took gas samples over 14 days and analyzed them for carbon dioxide and methane concentrations. Preliminary results show that the largest increase in carbon dioxide emissions was between the S. patens organic matter x S. patens soil (the current mid-marsh conditions) and the accompanying migration treatment S. patens organic matter x P. australis soil (mid-marsh migration to high marsh).This study will help us understand how the soil microbial community will react to a novel organic matter addition, and assist in understanding how carbon cycling will change due to marsh migration, informing future carbon budgets and land use.

Abstracts

Investigation of the Soil-Bedrock Interface in Tributaries Above and Below the Knickpoint of a Fall Zone Stream

Tristina Ting, Karen L. Prestegaard, John A. Harris, Mong-Han Huang

The Atlantic Fall Zone crosses the Northwest Branch Anacostia River near its mid-point. Urban development in the surrounding watershed is centered on flat ridgetops, with wide forested areas on the steep hillslope and valleys. Upstream migration of the main stem knickpoint has lowered the stream level by 20-30 m below the knickpoint, causing significant differences in tributary spacing and gradient above and below the knickpoint. We hypothesized that channel incision in the tributaries has exposed fresh bedrock to weathering, generating a layer of poorly weathered saprolite above the base of the tributaries. Therefore, the goal of this research was to compare soil characteristics exposed by the tributaries that enter the main channel above and below the knickpoint. Soils at the soil-bedrock interface below the knickpoint were expected to have higher bulk density and exhibit less weathering than interface soils below the knickpoint. Using a 1 cc bulk density sampler, we collected soil samples at ten hillslope profiles along four tributaries—two above and two below the knickpoint—to understand how channel incision is affecting bedrock weathering and hillslope soil characteristics. Samples were taken at 5 or 10 cm intervals for 1-4 m starting at the soil-bedrock interface or the base of the stream. Samples were weighed prior to being dried in a 110°C oven for 10 hours, then re-weighed. Using the wet and dry sample weights, we calculated the bulk density, gravimetric water content, and porosity of each sample. Sharp contacts between bedrock and soil were observed both above and below the knickpoint, and the bulk density for most of the measured profiles was within a range of 1.4-1.8 g/cc. Field observations of saturation and water content data suggested that groundwater is concentrated just above the soil-bedrock boundary. Below the knickpoint, seismic profiles of hillslopes adjacent to the tributaries indicate a soil-bedrock morphology that is similar to the small tributary profiles, which suggests that tributary erosion depth may be largely controlled by weathered soil depth.

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