LUQUILLO, PR **CRITICAL ZONE OBSERVATORY**

Bill McDowell – bill.mcdowell@unh.edu

Hot spots and hot moments drive key critical zone processes from the bedrock to the atmosphere.

The Luquillo CZO is in the USDA Luquillo **Experimental Forest in Puerto Rico and focuses** on the dynamic drivers of landscape formation, denudation, and carbon storage and loss via soil and stream processes. The CZO exists on adjacent tropical watersheds underlain by contrasting rock types that weather into soils with different physical and biogeochemical properties.

Our specific foci integrate:

- The role of knick points in landscape processes.
- The role of redox fluctuations in biogeochemistry.
- Sediment transport and stream morphology.
- Earth casting models that allow us to explore the role of climate and land use change on critical zone structure and function.





CUBA





SHALE HILLS, PA CRITICAL ZONE OBSERVATORY

Sue Brantley – sxb7@psu.edu

The Susquehanna/Shale Hills CZO is an environmental observatory for the study of the fluxes of water, energy, solutes, and sediments in the Shavers Creek Watershed of central Pennsylvania. The CZO brings together scientists from many disciplines to understand how to measure today's fluxes, and to use models to understand those fluxes and relate them to the history of those fluxes recorded in soils, sediments, and the landscape.

Models span the research from bedrock to the vegetation canopy and from geological to meteorological timescales. The CZO educates students to understand the form and function of the Critical Zone as it operates today and in the past. With models and scenarios of human behavior, we are learning to project how the environment will change into the future.



REYNOLDS CREEK, ID CRITICAL ZONE OBSERVATORY

Kathleen Lohse – klohse@isu.edu

Most of the world's terrestrial carbon is found in the critical zone, where it is predominantly stored as soil carbon and sensitive to climate change and land management. Despite its importance, soil carbon remains a large source of uncertainty in both carbon cycling and global climate models. Reynolds Creek Critical Zone Observatory (RC CZO) is focused on the guantification of soil carbon and the critical zone processes governing it. The RC CZO is addressing the grand challenges of improving prediction of soil carbon storage and flux from the pedon to landscape scale.







SOUTHERN SIERRA. CA **CRITICAL ZONE OBSERVATORY**

Roger Bales – rbales@ucmerced.edu

The CZO explores connections between regolith, water and overlying vegetation in the Sierra Nevada. Spatially distributed, high-frequency measurements of water, nutrient and energy fluxes are central to understanding ecosystem processes across a 2300-m elevation transect.

Overarching Goal:

Goals include predicting water-balance patterns, quantifying feedbacks between hydrologic and biogeochemical cycles, understanding the evolution of soils and landscapes over multiple spatiotemporal scales, and informing resource management.







Reading the record of the past

Measuring WESS fluxes today

Projecting the Anthropocen







- modern processes
- the surface

The CZO program is an initiative of the NSF Earth Sciences Division, Geosciences Directorate. The U.S. CZOs serve the international scientific community as a network of sites, data, models, and people.

Rich, connected datasets. Each CZO is building data sets, including LiDAR, hydrologic time series, and biogeochemical data. See criticalzone.org/data.



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CZO CRITICAL ZONE OBSERVATORIES





Research opportunities. The Critical Zone Observatory National Office (CZONO) fosters community engagement through logistical support and leadership for network-wide activities. See criticalzone.org/national/about.

criticalzone.org

BOULDER CREEK, CO CRITICAL ZONE OBSERVATORY

S.P. Anderson – suzanne.anderson@colorado.edu

Boulder Creek CZO uses the natural laboratory of the Front Range landscape to study the development of critical zone architecture under varying denudation processes, deep weathering front advance, and fluxes of water, nutrients, and sediment in all environments.

Science auestions:

- What is the legacy of long-term geologic history in the critical zone?
- What governs the dynamics of key interfaces within critical zone architecture?
- How do slope aspect, microclimate, rock properties, organisms, and rare events control fluxes?
- What feedbacks govern the co-evolution of the CZ and its hydrologic and ecological function?

een Lakes Valley

Gordon Gulch





CALHOUN, SC CRITICAL ZONE OBSERVATORY

Daniel Richter – drichter@duke.edu

In North America's Southern Piedmont, the Calhoun CZO organizes its research around guestions that span multiple scales of time and space.

- Does land degradation decouple upper and lower CZ systems by disturbing macroporosity networks of gas and water exchange? How rapidly can reforestation re-network the CZ into an integrated ecohydrologic and biogeochemical system?
- How has historic and severe erosion redistributed and altered minerals and organic carbon on both uplands and in floodplains filled with historic sediment?
- Can human-forced CZs enter new steady states with positive feedbacks and attractors that resist recovery?



eismic velocities illustrate deep and advanced weathering of interfluves St. Clair & Holbrook, unpublished data).







Calhoun CZO in the Southern Piedmont is a

Calhoun CZ in the 1950s after 150 years of

A severely eroded soil profile regene 80-years of reforestation

residual landscape intensively eroded by

historic agriculture

edmont farming

CATALINA-JEMEZ, AZ-NM CRITICAL ZONE OBSERVATORY

Jon Chorover – chorover@email.arizona.edu

The CZO comprises an elevation gradient on granite, schist and rhyolite in southern Arizona and northern New Mexico that spans a range in precipitation and temperature representative of the water-limited southwestern US.

Overarching science guestion:

• How does variability in climate, lithology and disturbance influence CZ structure and function over both short (hydrologic event) and long (landscape evolution) time scales? We postulate that CZ structure in a given geomorphic template evolves predictably in response to water, carbon and energy fluxes across the upper boundary

A nested watershed approach enables real-time measurements from pore-to-pedon-to-hillslopeto-catchment. Observations inform conceptual a and numerical models of long-term CZ structure, evolution, coupled dynamics, and their control over the provisioning of CZ services.



CHRISTINA RIVER BASIN, DE/PA CRITICAL ZONE OBSERVATORY

Anthony Aufdenkampe – aufdenkampe@stroudcenter.org

Spatial and temporal integration of carbon and mineral fluxes: a whole watershed approach to guantifying anthropogenic modification of critical zone carbon sequestration.

Overarching Goal:

To integrate the mineral and carbon cycles to advance our understanding of anthropogenic impacts on carbon sequestration.

Scientific Questions:

- Is carbon sequestration limited at watershed scales by the formation rate of organo-mineral complexes, which is in turn limited by the rate of mixing of fresh organic matter with fresh mineral surfaces?
- Do accelerated soil erosion and mixing associated with agriculture and construction increase complexation and thus sequester organic carbon within a catchment?











Christina River Basin

Floodplain

sites

anduse

end-member

watersheds



- drv environments?



IML. IA-IL-MN

Intensively Managed Landscape (IML)

Science Ouestions:

Study Sites: IML-CZO includes the 3,690-km² Upper Sangamon River Basin (IL) and the 270-km² Clear Creek Watershed (IA), & 44,000-km² Minnesota River Basin as a participating site.



The CRB-CZO focuses on the 1440 km²

Christina River Basin as a laboratory fo

EEL RIVER, CA

CRITICAL ZONE OBSERVATORY William E. Dietrich – bill@eps.berkeley.edu

The CZO focuses on intensive field monitoring in the critical zone to follow watershed currencies: water, solutes, gases, sediment, biota, energy and momentum These watershed currencies are tracked in the subsurface physical environment and microbial ecosystems into the terrestrial ecosystem, up into the atmosphere, and out through diverse drainage channel networks and mediating aquatic ecosystems.

Research Questions:

 Does lithology control rock moisture availability to plants and therefore overall resilience of vegetation to climate change in seasonally dry settings?

• How are solute and gas effluents from hillslopes influenced by biota in changing moisture regimes?

• What controls the spatial extent of wetted channels in the channel networks of seasonally

 Will changes in critical zone currencies induced by climate or land use change lead to threshold-type switches in river and coastal ecosystems?









CRITICAL ZONE OBSERVATORY

Praveen Kumar – kumar 1@illinois.edu

• How do time scales of geologic evolution and anthropogenic influence determine the trajectory of Critical Zone structure and function?

 How is the coevolution of biota and the soil affected by intensive management?

• How have the natural patterns of heterogeneity and connectivity across transition zones been changed?

• How do these changes affect the residence times and fluxes of water, carbon, nutrients, and sediment?





