SCHOOL OF EARTH AND ENVIRONMENTAL SCIENCES

Living in, discovering the critical zone

By Jon Chorover
SPECIAL TO THE ARIZONA DAILY STAR

The ongoing search for life on other planets reveals how fortunate we are to have the right balance of ingredients here on Earth. Our planet has 6.9 billion humans living on the Earth's land surface. This zone of the crust is critical because it provides us with fertile soil for growing food, clean water for drinking and habitat for a diversity of plants, microbes and animals. Precious landscape, indeed.

The "critical zone" stretches from the treetops to the bottom of the groundwater and can be thought of as a permeable, living filter in the larger Earth system. The thin green carpet of plants, microbes and animals directly controls how climate chisels away at the landscape, how it weathers rock to form soil and how it changes the quality of water during its transport.

Although scientists know a lot about the plant communities, soil fertility, geology and hydrology of the critical zone, we don't have a detailed understanding of how all the components interact to shape landscapes and clean and store our water. Therefore, the National Science Foundation and the European Commission recently created a network of 10 Critical Zone Observatories, six in the U.S. and four in Europe, to study this key component of our life-support system.

The University of Arizona is the headquarters of the Jemez River Basin-Santa Catalina Mountains Critical Zone Observatory.

This observatory, under the leadership of a group of faculty in the UA's School of Earth and Environmental Sciences, focuses on the Santa Catalina Mountains near Tucson and the Jemez Mountains north of Albuquerque. It is the only critical zone observatory that has research sites arrayed along elevation gradients in the semi-arid Southwest.

The mountains of Arizona and New Mexico host a range of rock types and climates. Temperatures and the amount of precipitation vary dramatically with elevation. Because geology and climate exert primary control over critical zone formation, the diversity in rock type and climate makes these mountains natural laboratories for critical zone science.

However, unraveling complex interactions among vegetation, soils, rocks and water requires close collaboration among ecologists, hydrologists, soil scientists and geologists. All of us must bring our state-of-the-art tools to the joint research effort.

Our UA-led team is setting up sensor networks in low, intermediate and high elevation watersheds in the two mountain ranges to measure how climate affects the flows of water and materials through vegetation, soils, groundwater and streams. We collect data on precipitation, soil moisture, plant uptake, aquifer recharge and stream flow during and between both rainfall and snowmelt.

During such events, members of our team of postdoctoral scientists, graduate students and undergraduate researchers rush to the field to collect samples of water, soil and plant tissue and bring them back for laboratory analyses.

We are discovering much about the critical zone. We are finding that soil depth and development strongly influence the partitioning of water in the landscape, the speed that it is delivered to streams and the unique chemical "fingerprint" it obtains during its journey.

JULIA PERDRIAL / UNIVERSITY OF ARIZONA

JON CHOROVER / UNIVERSITY OF ARIZONA

ABOVE: Research scientists Sarah Hayes and Adrian Harpold install soil moisture, temperature and solution probes to obtain information on the transit of water, soluble materials and heat through the critical zone subsurface. Wires transmit sensor results to data loggers for storage.

LEFT: UA research scientist Julia Perdrial excavates a soil pit before she installs sensors that will measure energy fluctuations in the subsurface. Red flags indicate the location of sampler installations.

ABOUT THE SCIENTIST

Jon Chorover is a UA professor of soil, water and environmental science. His research investigates the interaction of geochemical and biological processes in the critical zone. He is particularly interested in processes that influence the fate of metal and organic compounds. The research provides a foundation for novel approaches to remediation of impacted natural systems.

EXPERIENCE SCIENCE

More about the critical zone:
www.czo.arizona.edu
UA Department of Soil, Water and Environmental Science:
ag.arizona.edu/SWES/

ABOUT THE SCHOOL

The School of Earth and Environmental Sciences generates knowledge, provides the scientific basis for environmental and climate policy and trains the next generation of earth and environmental scientists. The school comprises the Departments of Atmospheric Sciences, Geosciences, and Hydrology and Water Resources plus the Laboratory of Tree-Ring Research and the Department of Soil, Water and Environmental Science.