UC SANTA BARBARA

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Champions of the Forests

Riparian forests — the ribbons of trees that grow along river channels — play an important ecological role as refuges for endangered species in dry areas. But these natural havens are increasingly threatened by the changing frequency and intensity of drought, both of which are byproducts of climate change.

Scientists at UC Santa Barbara are studying how riparian forests respond to climate change that manifests as hotter and drier conditions over time. With $2.5 million in combined funding from three grants, Michael Singer, a researcher with the Earth Research Institute (ERI), and colleagues seek to understand the impact of nonstationary climate — trends in temperatures and precipitation — on riparian forests.

“As a river starts drying up, groundwater-dependent trees like those in a riparian forest might disappear, or the moisture within the soil might dry up, affecting more shallowly rooted trees and shrubs,” explained Singer, who also is a lecturer at Cardiff University in the United Kingdom.

Through the National Science Foundation’s Geography and Spatial Sciences Program, one project — led by associate professor John Stella of the State University of New York College of Environmental Science and Forestry (SUNY-ESF) — is being conducted near UC Santa Barbara in Ventura County’s Santa Clara River Valley. A basin with competing water needs — ecological, urban and agricultural — the Santa Clara, because it goes dry, relies largely on subsurface groundwater. Continual pumping of groundwater from the aquifer for agriculture, when that aquifer is not

recharged by rainfall, causes wells to go dry and forces pumping efforts to reach deeper and deeper.

Innovative new legislation in California, the Sustainable Groundwater Management Act (SGMA), shifts the management of groundwater resources from the state to local basins, requiring regional stakeholders to create action plans for managing water resources. With the grant, Singer and Stella will collaborate with geography professor Dar Roberts and The Nature Conservancy to develop an improved understanding of forest health along the Santa Clara River. They'll investigate matters including what happens to trees that are rooted at depths below the surface with diminishing groundwater, and their findings can be used to administer SGMA.

Through another NSF grant, in its Hydrologic Sciences Program, Singer, Stella and ERI director Kelly Caylor, also a professor in the Bren School of Environmental Science & Management, will study riparian forests along a major European river. The Rhône, which flows through France from Lake Geneva to the Mediterranean Sea, warms 2 degrees Celsius along its climate gradient. The researchers plan to measure the variation in temperature, precipitation and climate to model what might happen under climate change and determine how water availability to forests shifts due to climate and how trees are using water, as well as their corresponding growth and health outcomes over time.

The scientists also will core trees to determine their age and will extract cellulose from individual rings for isotopic analysis. Oxygen isotopes are used to distinguish water sources such as groundwater or rainfall, while carbon isotopes reveal how efficiently trees are using that water — a calculation of photosynthesis versus water loss.

The third project is funded by the Department of Defense through the Strategic Environmental Research and Development Program. Singer, Stella, Roberts and Caylor will develop a toolkit and provide quantitative support for land and water conservation management to promote the sustainability and resilience of riparian forest ecosystems located on DOD lands. The endeavor focuses on three dry area bases in drought-prone regions: Vandenberg Air Force Base near Lompoc; Marine Corps Base Camp Pendleton in San Diego County; and the driest, U.S. Army Fort Huachuca in southeastern Arizona.

“In all of these studies, we’re developing water stress indicators, which can be physical manifestations such as dropping leaves or branches or trees becoming less green,” Singer explained. “Such markers can be seen in remote sensing imagery and tree-ring isotopes, but we’re also looking at climate records for precipitation and temperature, along with numerical modeling to determine what type and how much water has been delivered to a basin in the first place. If we see trends that tell us the forest is really suffering, we hope to establish an early warning response window in which managers can act quickly before important patches of forests are lost.

“Combined, those various metrics give us a good idea of how well trees are doing,” Singer added. “We hope to integrate the results of these projects to eventually predict the thresholds of species collapse and perhaps even forest collapse. If we can identify what the dominant controls on those thresholds are climatically, we may be able to assess whether trends in temperature are more relevant than those for precipitation.”

About UC Santa Barbara

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