California Institute for Water Resources
University of California

Annual Technical Report
2019

Products

Allaire, M., Mackay, T., Zheng, S., Lall, U. (2019). Detecting Community Response to Water Quality Violations Using Bottled Water Sales. *Proceedings of the National Academy of Sciences*. 116(42)20917-20922

Blog post written by science writers at Environmental Monitor, a Fondriest publication for environmental professionals, about our research: https://www.fondriest.com/news/heart-of-monitoring-blue-oak-ranch-reserve-takes-the-pulse-of-the-wild.htm

Blog post written by science journalist at UC Office of the President about our research: https://news.ucsc.edu/2020/04/arbor-creek-watershed.html

Zimmer Margaret, *Grande, Emilio, John, Mallard, 15 December 2020, Dynamic catchment water storage-discharge partitioning across water- and energy-limited catchments, Abstract H205-04, American Geophysical Union Fall Meeting, Virtual, Oral.

Giggy, Lauren, Margaret, Zimmer, 15 December 2020, Characteristics of surface water persistence in a non-perennial stream network, American Geophysical Union Fall Meeting, Virtual, Poster.

Donaldson, Amanda, Margaret, Zimmer, Kerri Johnson, Mong-Han Huang, 15 December 2020, Slope-aspect dependent hillslope water storage capacity, threshold responses, runoff generation, American Geophysical Union Fall Meeting, Poster.

Donaldson, Amanda, Margaret, Zimmer, April 1 2020, Quantification of water storage and non-perennial runoff dynamics in a semi-arid catchment, Salmonid Restoration Federation Annual Meeting, Santa Cruz, CA. Oral. (cancelled due to COVID-19 restrictions)

Donaldson, Amanda, Margaret Zimmer, Dec 7 2019, Critical Zone Controls on Coupled Differential Plant Water Source Uptake, Subsurface Water Storage, and Streamflow Processes, Abstract H33H-2009, American Geophysical Union Fall Meeting, San Francisco, CA, Poster.

Zimmer, Margaret, *Amanda, Donaldson, July 17 2019, Catchment Hydrology at Blue Oak Ranch Reserve, Terrestrial Biodiversity and Climate Change Collaborative, Pepperwood Preserve, Sonoma, CA. Oral.

Zimmer, Margaret. January 26, 2019, Vegetation, hydrology, and landscape evolution in California. UC Santa Cruz Plant Science Symposium, Santa Cruz, CA. Oral.

Fournier, R.; G.de Mendoza, R. Sarremejane, A. Ruhi, May 9, 2021, “Recolonization pathways of macroinvertebrate communities in intermittent streams: does isolation

matter?", Will be presented to the 2021 annual meeting of the Society for Freshwater Science.

Lee, J., Nemati, M., and Dinar, A. (2021). A Historical Trends of Residential Water Use in California: Effects of Droughts and Conservation Policies. Applied Economic Perspectives & Policy. https://doi.org/10.1002/aepp.13149

Singh, A., Haghverdi, A.,Nemati, M., & Hartin, J. (2020). Efficient urban water management: II.Weather-based smart irrigation controllers. UC ANR Publication Series.

Nemati, M., Haghverdi, A., & Hartin, J. (2019). Efficient urban water management: I. Understand-ing your residential water bill and motivation to save. UC ANR Publication Series.

Residential Water Consumption Trends in California: 1994-2019. ARE Update, University of California Giannini Foundation of Agricultural Economics. Under Review.

Nemati, M.& Wright, I. (2019). Pricing structure and urban water demand in California Association for Public Policy Analysis and Management (APPAM) Regional Student Conference, Apr 12-13, UC Irvine, Irvine CA.

Information Transfer Program

(COVID-19 lockdowns limited the outreach the past year; in-person programs have been delayed.)

Science communication: We continue to grow an already strong web presence. Our Twitter followers, numbering over 9,000, are composed of journalists, academics from across the country and world, nonprofits, agencies, and concerned communities. We continue to work to communicate University based science to our stakeholders, with a renewed focus on highlighting the work of a diversity of researchers across the UC and CSU systems. Findings of various project activities were shared with landowners, consultants, agency staff, ngos, and academic researchers.

Student Support

Masters Students:
Federal Funds: 1 Matching Funds: 2 Total: 3

PhD. Students:
Federal Funds: 8 Matching Funds: 2 Total: 10

Other Acad./Researchers:
Federal Funds: 3 Matching Funds: 2 Total: 5

Professor/Summer:
Federal Funds: 0 Matching Funds: 1 Total: 1

Total:
Federal Funds: 12 Matching Funds: 7

GRAND TOTAL: 19

Notable Achievements and Awards

UC-Irvine Faculty Mentor of the Month (2020): Recognition for outstanding efforts in mentoring undergraduate research, from the UCI Division of Undergraduate Education. (Allaire)

Grant: Columbia World Projects. “Addressing the Gap in Reliable, Affordable Wastewater Services to Protect Public Health”. ($710,000 total; $66,533 to UCI) 11/2020- 4/2022 (Co-PI). *CIWR support allowed my research group to produce preliminary research findings that resulted in a successful grant proposal.*

Principal Investigator Zimmer, UCSC Hellman Fellows Program, Quantification of groundwater recharge in non-perennial rivers, FUNDED, $25,436

PI Ruh has recently been notified of an NSF CAREER Award for the project “Drought and metacommunity stability in riverine networks” (DEB-2047324), which builds on the proposed research and will extend drought biomonitoring efforts and field experiments at Chalone Creek, Pinnacles National Park.

Assessment Of Water Storage For Management Of California's Oak Woodlands

Project Type: Annual Base Grant
Project ID: 2019CA025B

Project Impact:

This work used geophysical, hydrological, and isotopic approaches to understand the controls on water storage and movement in a semi-arid coastal watershed in California's southern Diablo Mountain Range. We found that shallow subsurface structure (from 0-5 m below ground) was relatively uniform across north and south facing slopes, which was surprising given previous research at other semi-arid watersheds across western US that showed deeper soil profiles on north facing slopes. We hypothesize the lithological complexity of the resident Franciscan Melange is driving this unanticipated pattern. That said, we found that below 5 m depths, north facing slopes have deeper depths to unweathered bedrock, which suggest heightened water storage and bioturbation from tree roots have produced asymmetric subsurface material weathering. This has implications for plant water availability during dry and drought conditions. We found significantly higher water storage on north facing slopes in the top 1 m of soil, which allowed grasses on these slopes to stay active longer into the growing season. We also found more rapid soil moisture response during precipitation events on south facing slopes. As the adjacent non-perennial stream activated when certain soil moisture content thresholds were reached on south facing slopes, we hypothesize rapid lateral flow in south facing slopes controlled stormflow generation. Together, this work helps better inform our understanding of the subsurface structure of similar semi-arid landscapes, which directly influences water storage and streamflow generation in these watersheds.

Towards A Mechanistic Understanding Of The Multi-Scale Effects Of Drought On Riverine Biodiversity

Project Type: Annual Base Grant
Project ID: 2019CA026B

Project Impact:

Biota in intermittent streams have evolved a wide range of adaptations to drought. However, the relative importance of resistance and resilience strategies—and how they are facilitated spatially—remains largely untested. Our goal with this study is to develop a mechanistic understanding of how macroinvertebrate populations respond to seasonal drought by quantifying how habitat fragmentation (i.e., distance from persistent waters) mediates various reestablishment pathways. To that end, we implemented a dispersal experiment in Chalone Creek at Pinnacles National Park. In fall 2019 we designed and constructed 45 mesh traps that prevented recolonization via all pathways but one (e.g., vertical, aerial, up/downstream) and placed them during the re-wetting period at sites of increasing longitudinal distance from a perennial water source. The dispersal experiment ran from December 2019 through January 2020. Sample processing began shortly thereafter, in February 2020. However, in March 2020, the COVID-19 pandemic caused all in-person research at the University to cease—halting sample processing. As research activities restarted across campus, sample processing could not resume as the postdoc leading the project was unable to re-enter the United States for the remainder of their appointment. As of mid-January 2021, sample processing has resumed (led by Dr. Robert Fournier, new postdoc in the lab). Results of this study remain forthcoming as sample processing progresses; however, preliminary abundance estimates from one site highlight the relative importance of storage effects for stoneflies, while other taxa largely recolonized via upstream migration. The full results of this study will help to develop a greater understanding of how organisms respond to and persist through drought events.

Determining The Effect Of Pricing Structure On Urban Water Demand: A Long-Term Analysis Of Major Water Utilities In California

Project Type: Annual Base Grant
Project ID: 2019CA027B

Project Impact:

Quantifying price structure effect on water demand and conservation has direct implications for the water utilities, many of which are considering this strategy as a mechanism to encourage conservation; as well as, helps to answer major questions relevant to policymakers such as the State Water Resource Control Board. These include: (i) How are water consumption, prices, and pricing structure changing within utilities in California? (ii) How are residential customers react differently to the structure changes? (iii) What are the most effective pricing structures that can promote water conservation? (iv) Have households' cultural norms such as the desire for a lawn in lieu of reducing water costs by planting more drought-resistant plants changed after the 2012-2016 historic drought, and as a result, will customers react differently to price changes?" moreover, (v) how long does the structure change maintain?
The first-year has been directed towards a comprehensive dataset creation of residential water prices and pricing structure throughout California during 1994-2019. The second-year has been evaluated the sensitivity for estimates of price elasticity of water demand in the single-family residential sector under different sets of demand assumptions, including pricing structure. This project shows that greater sensitivity of demand to price and greater conservation in the case of conservation-based structures (i.e., tiered and budget structures) are supported, but it also is paying attention to the asymmetric effect on structural change. This implies that interventions can yield long-term behavioral change that is additive when treatments are continued and persist after the treatments are discontinued.

Precision Irrigation Management For Optimizing In-Season And Post-Harvest Use Of Limited Water In Young And Mature Almond Orchards

Project Type: Annual Base Grant
Project ID: 2019CA028B

Project Impact:

The goal of this project is quantify crop water use or evapotranspiration from 1st leaf, 2nd leaf and 3rd leaf almond orchards and consequently determine crop coefficients for the different ages of young almond orchards that are currently not available.
In summary, the objectives of the study were to (1) evaluate precision irrigation management of different varieties of almond trees in the same orchard, (2) evaluate regulated deficit irrigation management of almond orchards during the pre-harvest and post-harvest periods and its effect on bloom, yield, nut quality, and water productivity, and 3) evaluate crop water use of young almond orchards and determine corresponding crop coefficients. Research questions (1) and (2) will be addressed in a randomized complete block design experiment in a 4 acre almond orchard at Nickels Soil Lab in Arbuckle, CA and (3) will be addressed in commercial orchards with first, second, and third leaves almond trees in Corning, CA. Project was delayed due to the COVID-19 lockdowns, results will be available at a later date.

Groundwater Regulation And Land Fallowing: How Does Water Scarcity Impact Land Use?

Project Type: Annual Base Grant
Project ID: 2019CA029B

Project Impact:

Our research results support sustainable agriculture in a changing climate by informing water management and policy in California and elsewhere. This research evaluates a volumetric pricing program from California's central coast that was implemented to address water quality and quantity externalities arising from groundwater irrigation. First, we use detailed data on farm-level land and groundwater use to identify the short-run effects of a volumetric water assessment on groundwater use, crop choice, land fallowing, and land conversion. We find that farmers responded to a large price increase with a 10-15% decrease in overall groundwater extraction and a 17% decrease in total agricultural land. Crop switching towards high-value crops and a reduction in fallowed land also occurred. This research provides empirical evidence that volumetric groundwater pricing can lead to significant resource reallocation, with movement out of agricultural production. In characterizing the relationship between water scarcity and farm-level decision making, this research identifies the extent to which water policies affect the farm economy through changes in irrigated acreage. Second, we combine panel measurements of groundwater salinity and fine spatial land use data to predict the likelihood that farmers shift crops in response to a change in groundwater salinity. Our model indicates that growers are willing to pay between $96 and $1,155 per acre for a 10 mg/L reduction in total dissolved solids depending on the crop. We simulate that a 100% increase in total dissolved solids would reduce regional economic welfare by $106 million or approximately 10% of annual agricultural revenues. Results can be used to inform investments designed to prevent saltwater intrusion.

Assessing Health Impacts Of Impaired Water Quality In California

Project Type: Annual Base Grant
Project ID: 2019CA030B

Project Impact:

Ensuring safe drinking water remains a challenge for communities across the country. In California, growing awareness of inadequate access, especially for disadvantaged communities, has elevated water quality issues to the state-level. Currently, over one million Californians are estimated to lack access to safe water. Yet, the full scope of this challenge is unknown.

Few studies in the United States address disproportionate exposures to water contaminants. This study contributes to the emerging literature on water equity by assessing disparities at the level of a water system. To do so, we create a water system level demographic dataset. Using logistic regressions and spatial analysis, we shed light on disproportionate exposure to water contaminants.

We find evidence of environmental justice concerns. Low-income areas and communities of color face greater likelihood of health-related violations. Serving a state-designated disadvantaged community is associated with an increase of 1.1 percentage points in the probability of any violation. This rises to 2.8 percentage points for severely disadvantaged communities. These average marginal effects are sizeable, when considering that 9.1% of water system-year observations have a violation. African American-serving systems face disproportionate arsenic violations, while Latino-serving systems face higher likelihood of nitrate violations. Disparities in violations appear to worsen over the 2000-2018 study period. Severely disadvantaged communities in 2018 faced much greater violation prevalence (10.7 percentage points higher). Persistent gaps in compliance also exist for African-American and Latino-serving systems. Actionable information is created by analyzing trends in violations across the state and identifying systems with frequent and severe noncompliance