FRESNO STATE

California Water Institute

Inaugural Fresno State Water Showcase

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PROGRAM

Biogeochemical controls on natural and anthropogenic groundwater contaminants in the San Joaquin Valley

By Aric Mine and Brady Ziegler

The San Joaquin Valley is home to some of the most productive agricultural land in the United States. Agricultural productivity is supported by important groundwater and surface water resources; both of which support additional municipal and industrial demands. Increased frequency of drought places strain on essential water resources throughout California. In addition, the Central Valley faces a host of challenges related to anthropogenically-induced contaminants in groundwater. Groundwater contaminants present human health hazards and financial strain to municipality's water treatment costs. Notable contaminants in the Central Valley include nitrates, heavy metals and pesticides; all of which can induce biological and geochemical processes that exacerbate the release of trace elements (e.g., uranium, chromium, arsenic) from immobile phases in sediments to a dissolved phase in groundwater. This problem may also be intensified by increasing groundwater pumping and extraction and its destabilizing effects on aquifer sediment geochemistry. We sampled a range of wells in the Central Valley; testing the water for contaminants, microbes, and characterized aquifer sediment geochemistry to create a complete mechanistic picture for contaminant release and mobilization in the subsurface. The overall goal of this research project is to better resolve the influence of human activity on biological and geochemical processes that enhance groundwater contamination in the Central Valley. A more complete understanding of contaminant processing will support efforts to mitigate groundwater contamination and reduce municipal financial burdens for treatment.

Subsurface Artificial Groundwater Recharge (SAGR) at Fresno State

By Cordie Qualle and Andrew Gutherie

Present research conducted to date using the existing SAGR system and what we plan to accomplish in 2022, assuming there is sufficient water to conduct research.

House Price Capitalization of Stormwater Retention Basins: Evidence from Fresno-Clovis Metropolitan Area in California

By Andres Jauregui, Qin Fan, and Jacquelin Curry

We extend the literature on the impact of stormwater retention basins on house prices and time on the market. Our results indicate that properties located closer to a basin sell at a discount relative to properties located farther away, but the impact is not linear. We further provide evidence that homebuyers pay premium prices to be located closer to a basin in construction, yet as the basin ages, property prices decrease. Although stormwater basins provide benefits for the community, results suggest that proximate households generally bear the cost. In the locations adjacent to the basins, discount prices of proximate homes tend to be larger in low-income areas.

Production of Agricultural Water and Nutrients from Nontraditional Water Sources

By William Wright, Karl Longley, Walter Mizuno, and Sankha Banerjee

Due to climate change, inland agricultural regions are increasingly experiencing water scarcity and higher salinity in water sources. Precision separations are required to extract phytotoxic constituents and nutrients from brackish water sources enabling use as irrigation water and reducing agriculture’s dependence on fertilizers. Initial and final components of a multi-component water and nutrient recovery system are being developed for the fertigation of crops and irrigation. An innovative electrodialysis process will be used to separate sodium chloride from the source water to improve the efficiency of the downstream ion exchange processes allowing treatment of higher TDS source waters. A new water stream is created in areas where conventional water sources are diminishing. Fertilizer and water transportation requirements are reduced, saving energy, and lowering GHG and NOx emissions.

Groundwater Use and Housing Development

By Qin Fan and Dr. Jiaochen Liang

After many years of drought, California is challenged to manage its water resources to mitigate the economic impacts of water stress on different markets including housing market. An important question arises as to whether water availability affects housing development and how, considering water sources. The Sustainable Groundwater Management Act (SGMA) passed in 2014 in California requires local agencies to meet certain requirements and will subsequently affect land use decisions of land use planning agencies after its full implementation by 2040. Currently, groundwater deficit especially in San Joaquin Valley is facing negative impacts from overdraft including land subsidence. Therefore, water availability directly affects land availability thus affecting housing supply.

A simple economic model is used to regress the change in housing units (2011-2012) on water consumption per capita in 2010 using log-log functional form. Results suggest that groundwater withdrawals for public supply per capita negatively affect residential development based on the full sample in the U.S. Based on the subsample that only includes 58 counties in California, the magnitude of negative impact of groundwater withdrawals becomes even larger. The results provide empirical evidence for negative impacts of groundwater withdrawals on housing supply possibly due to land subsidence and land availability in association with the impact of groundwater overdraft.

Copper Storage in Remote Alpine Lake Food Webs in Sequoia National Park

By Kelly Martin, Dr. Steve Blumenshine at Fresno State, and Erik Meyer at the National Park Service

Copper-based pesticides are widely used as an agricultural practice in California's San Joaquin Valley, but impacts of these applied pesticides can be observed far from the source. Models predict that trace copper particles are atmospherically transported and deposited across landscapes over many dimensions. Pristine alpine lakes in Sequoia National Park are not immune to the deposition of pollutants, including copper, that can accumulate in the tissues of aquatic organisms. Elevated copper concentrations are particularly toxic to aquatic species. Previous studies have identified threats of copper toxicity, but none have addressed impacts to Sierra Nevada montane lake food webs. Furthermore, introduced brook trout (Salvelinus fontinalis) have altered food web and trophic structures in many historically fishless lakes. My research objective is to assess whether differences in food web composition will have a significant influence on copper storage in a remote lake basin in the Sierra Nevada mountains. Six lakes in the Tokopah Basin of Sequoia National Park were chosen for this in-situ study, including three lakes sustaining brook trout populations and three fishless lakes. Benthic macroinvertebrates, zooplankton, and fish will be collected and analyzed for copper accumulation in all six lakes. I predict that food web composition, influenced by the presence or absence of fish, will alter copper mobility and accumulation. This research will strengthen the understanding of copper-based pesticides and how these pollutants can impact organisms living miles from the source.

Water Politics and Policy

By Thomas Holyoke

An overview of a new book I am writing on water politics and policy in the American west.

Engaging students in course-based undergraduate research experiences on the San Joaquin River

By Mara Brady, Beth Weinman, and Aric Mine

A long-term effort to restore flows to the historically-dammed San Joaquin River began in 2009 to support a self-sustaining Chinook salmon fishery. The challenge of doing so without compromising water supply needs along the San Joaquin River presents a unique opportunity for student and faculty researchers to investigate changes in the river over time under restoration flows and to analyze conditions that promote salmon habitats and spawning. In collaboration with the U.S. and California Department of Fish and Wildlife, EES undergraduates have been conducting research on sediment grain size changes in the San Joaquin River and how that impacts salmon habitats. This mutually-reinforcing partnership provides students a hands-on experience engaging in real-world problem solving and also provides additional hands and minds help address the complex needs of water supply and habitat restoration in the San Joaquin River. The results from the student research will contribute to long term sediment management plans for the San Joaquin River Restoration Program.

Repurposing of Nutrient Rich Water Using Algae?

By Kalyani Maitra, Dr. Aric Mine and Dr. K. Sun

Algae are known to assimilate nitrate and phosphate at high rates during their growth period. This property of algae can find potential application in water treatment operations to remove nutrients and improve water quality. Several water treatment plants and facilities across the globe have adopted this friendly approach during the early stages of the water purification or reclamation process. This bioremediation process of improving water quality provides a multiprong approach toward a sustainable bioeconomy. The harvested algal biomass, which is one of the end products, holds great potential to function as an alternate resource for biofuel, protein, oil, and carbohydrate that can provide a solution for the energy, food, and biotech industries and meet the need of the growing population. Algal cells can be manipulated to have high nutritional value with extractable lipids, protein, and starches which makes 'algae' an important, lucrative commodity to the industrial and the agricultural sectors.

Several algal species were grown aseptically in water collected from the community following its cultivation in bioreactors under a controlled laboratory environment. Algae growth was monitored via measuring cell optical density readings and cell count. Nitrate and phosphate concentrations were tracked at regular intervals via spectrophotometric measurements. The nutrient uptake capacities of the different algal species were closely monitored through the growth period of the cells. Using varying growth conditions, the rate of accumulation of starch, lipid, and protein in the harvested algal biomass is currently under investigation. The results from these experiments will help us understand the viability of algae to function as a useful feedstock for biofuel, food, and other useful related bioproducts.

The Aesthetics of Water: Connecting Science, Industry and Community through Arts and Humanities

By Alison Mandaville

How can tools in the arts and humanities bring general audience/public awareness and attention to the science of local and global issues of water? How can scientists and industry gain a deeper understanding of the affective human experiences of water by individuals and communities? I will share examples of specific creative activities and communication tools that, through integration of the senses and the sciences, can help the non-scientist engage empirical questions about water use, allocation, quality, and planning AND help those in science and industry integrate understanding of the aesthetics of human relationships to and experiences of the same.

A Taste of Fine Water Research

By Kevin Capehart

Dr. Capehart will present his recent work on the high end "natural" bottled water market, as well as his earlier work on that market published as "Fine Water: A Blind Taste Test" (https://doi.org/10.1017/jwe.2017.50) and "Fine Water: A Hedonic Pricing Approach" (https://doi.org/10.1017/jwe.2015.15) in the Journal of Wine Economics. The crucial question underlying this research is which (if any) aspects of that or other bottled water markets can be socially justified.

Efficient Water Allocation for Salmon Restoration; Application of Quantitative Approaches

By Steve Blumenshine

California's human and natural systems face a complex set of competing demands for freshwater. Agriculture in the Central Valley relies on a complex water management system that has been the focus of nearly constant legislative, legal, and political battles. As a result, many riverine ecosystems depend on mandated "environmental flows" released by upstream dams, which become a point of contention during critically dry periods. Thus, river conservation will require innovative strategies for restoring and sustaining valuable native species such as Chinook salmon. The likelihood of an increasingly variable yet diminishing supply of stored surface places a premium on efficient water allocations for conservation, especially for Central Valley rivers. The primary objectives and goals of our research are to advise water and natural resource managers on water allocation effects on restoration of the San Joaquin River for the previously extirpated & threatened Chinook salmon. We focus on a series of quantification steps to estimate the carrying capacity of salmon in the San Joaquin River in relation to goals of the San Joaquin River Restoration Program and it's Fisheries Framework. The primary goals of the SJRRP are basically to restore a self-sustaining Chinook salmon population to the San Joaquin River and to minimize adverse water supply impacts to water contractors. While these goals may seem mutually incompatible (salmon need 'more' water), they are possible with science-based analyses of how to meet both goals through the understanding of how much water and river habitat is needed to meet the salmon restoration goal. Our work includes a set of modern and cutting-edge tools to approach river restoration and salmon conservation. Our objectives are a basis for addressing this critical linkage between water supply and restoration.

Groundwater Data Sources and SGMA

By Chris Johnson

Groundwater management in California is critical for continued use of this resource, in an equitable and effective manner. Managing groundwater relies on meaningful and reliable data. The State Groundwater Management Act clearly calls for such useful data in the mandates established by the State to accomplish this equitable and effective management. Unfortunately, much of data currently available regarding groundwater conditions is derived from irrigation wells, which are the most widely spaced, but are singularly not designed, operated, or maintained as classic monitoring wells. Therefore, much of the data in play for the current management regime is likely fraught with unrepresentative data. This presentation will seek to explain the issue with the data sources and provide recommendations for more effective data sources.

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