Environmental Sciences Graduate Program Symposium

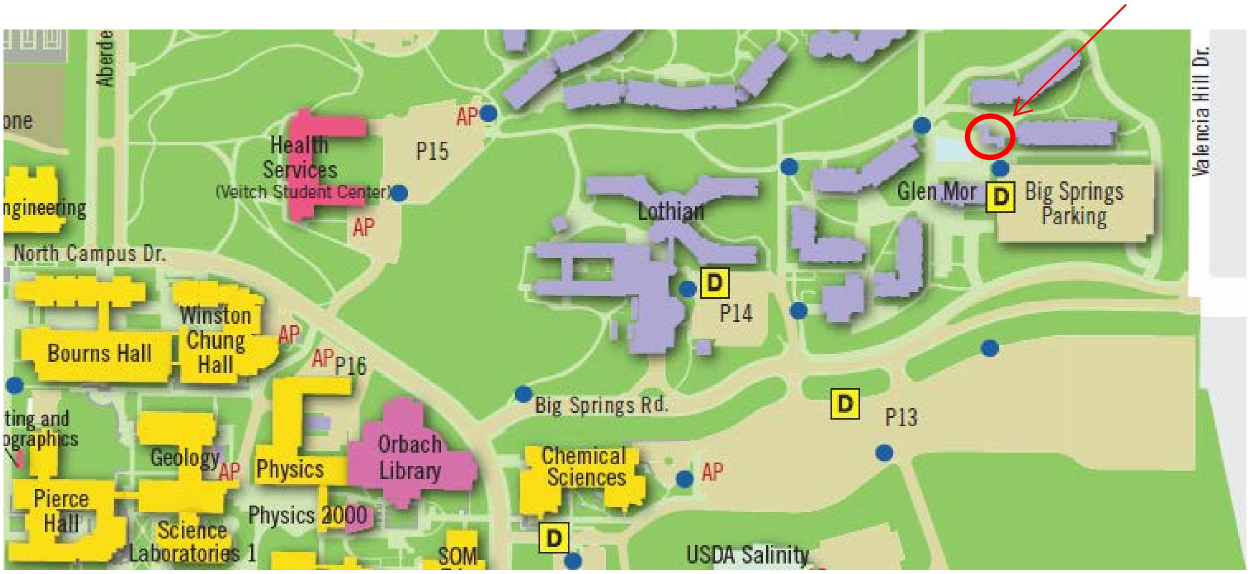
UCR Glen Mor K106/K108, September 19, 2019

8:00 am	**Continental breakfast (coffee included)**
8:30	**Welcome and introduction of new students**
8:45	Nathan Sy
9:00	Yaxin (Jane) Xiong
9:15	Nicolette Andrzejczyk
9:30	Sarah Helalia
9:45	Tiantian Zhou
10:00	**Coffee Break**
10:45	Amninder Singh
11:00	Yaning Miao
11:15	Linia Tashmim
11:30	Yumeng Cui
11:45	Claudia Avila
12:00 noon	**Lunch on your own**
2:00 pm	Valerie Carranza
2:15	Isis Frausto-Vicencio
2:30	Talha Rafiq
2:45	Michael Rodriquez
3:00	Anish Sapkota
3:15	**Coffee and Snack Break**
3:45	Aarushi Jha
4:00	Win Cowger
4:15	James Guilinger
4:30	Nathan Jumps
4:45	**Break**
5:00-7:00 pm	**Reception (dinner catered by Citrus Grove Catering)**

Map to Venue

The Symposium will be held at the Glen Mor student housing area in Room K which is located northwest of the Big Springs Parking structure and to the east of the swimming pool.

Glen Mor K106/K108



Symposium Abstracts

September 19, 2019

Pyrethroid insecticides in California urban catch basins and resistance development in associated populations of *Culex pipiens* mosquitoes

Nathan Sy

Major Professor: Jay Gan

Insecticide resistance is an ever-present challenge to pest management and risk to public health. Pests can become tolerant via several possible mechanisms to one or more pesticides, after which they may proliferate or spread to new areas. This phenomenon in mosquitoes, which are vectors of multiple human diseases, is especially a source of concern in California. Public (public health applications) and private entities (landscaping, structural control) alike may employ pesticides, such as pyrethroid insecticides, to curb infestation, but this may foster resistance and thus hamper long-term efforts. Urban settings also have multiple avenues, including concrete surfaces and catch basins, by which pesticides may be retained and released over extended periods of time. This project, conducted in collaboration with multiple vector control districts in California, seeks to study pyrethroid concentrations in urban catch basins along with resistance development in local mosquitoes and determine whether there is an association. Sites in multiple regions of California were selected for sampling throughout several summer months. Samples of water and various solids were collected from several basins at each site, while mosquitoes from the *Culex pipiens* species complex were caught with traps and used to raise colonies to a specific age for testing. Environmental samples were extracted for 9 pyrethroid analytes using accelerated solvent extraction (ASE), solid phase extraction (SPE), and liquid-liquid extraction (LLE). Reared mosquitoes were subjected to resistance bottle bioassays using 2 pyrethroid standards. Based on the results of this project, further work may expand the pesticides tested for, the number of sites sampled, and the depth of research into the mechanism(s) and sources behind any pesticide development.

The back conversion of alkylated pharmaceuticals and personal care products (PPCPs) inside plant cells and water fleas reveals a new metabolic pathway

Yaxin (Jane) Xiong

Major Professor Jay Gan

Pharmaceuticals and personal care products (PPCPs) are widely used in our daily life for health and cosmetic reasons and are detected world-wide in aquatic and terrestrial environment in recent years, raising public concern about their potential risk to ecosystem and human health. Microorganisms, animals and plants in the environment are capable of transforming PPCPs into various products. For example, triclosan and diazepam can be metabolized to methyl triclosan and nordiazepam, respectively. However, the transformation of PPCPs is not just such a simple, linear process. Our previous studies showed that methyl triclosan could be back converted to triclosan in plant cells, whole plants, earthworms and soils. Triclosan was detected in *Arabidopsis thaliana* cells after exposed to methyl triclosan for 12 h, and the concentration of triclosan continually increased during the exposure period. 15% of the total methyl triclosan back converted to triclosan after a 42-day incubation in the sandy soil. Additionally, after exposure to methyl triclosan in hydroponic condition at 1 mg/L, triclosan has been detected in all tissues of radish (from 0.052 ± 0.054 to 1.5 ± 1.2 μg/g dw) and in root tissues of cucumber (1.1 ± 1.1 μg/g dw). These results indicated a new metabolic pathway of PPCPs in the environment. But many limitations still remain in these studies. And my research would investigate whether the similar metabolic pathway of other PPCPs, such as diazepam and nordazepam, and acetaminophen and phenacetin, exist not only in plant cells (*Arabidopsis thaliana*) but also in aquatic invertebrates, such as *Daphnia magna*. Also, the bioaccumulation and toxicity of the alkylated PPCPs would be obtained and compared with the original PPCPs to better illuminate this new metabolic pathway.

Whole-Transcriptome Sequencing of Epidermal Mucus as a Novel Method for Oil Exposure Assessment in Juvenile Mahi-Mahi (Coryphaena hippurus)

Nicolette Andrzejczyk

Major Professor: Dan Schlenk

To prevent further disruption of wild populations, development of noninvasive sampling methods has become increasingly important when studying toxicological effects of environmental pollutants on aquatic organisms. In fish, analysis of eidermal mucus is a promising route for development of noninvasive sampling methods. To examine the efficacy of differential gene expression in mucus as a sampling method after oil exposure, juvenile mahi-mahi (*Coryphaena hippurus)* were exposed to control seawater or high energy water accommodated fractions of *Deepwater Horizon* slick oil for 48 hours. Whole-transcriptome sequencing revealed differential expression for 501 transcripts in the low oil exposure (∑PAH 16.55 µg/L) and 196 transcripts in the high oil exposure (∑PAH 23.03 µg/L), suggesting dynamic regulation of mRNA in epidermal mucus following oil exposure. Aside from expression of well-established biomarkers of PAH exposure (such as *cyp1a1*), the mucosal transcriptome showed differential expression of transcripts involved in immune response, cardiotoxicity, and calcium homeostasis that parallel molecular responses in whole embryos. The consistency of expression changes in the epidermal mucus compared to tissues obtained from lethal sampling suggest that mucus is a promising vector for noninvasive monitoring techniques.

Modeling analysis of root zone soil salinity in selected drip-irrigated orchards of San Joaquin Valley (SJV), CA

Sarah Helalia

Major Professor: Jirka Šimůnek

The long-term accumulation of salts is causing a serious risk on the agricultural production. Therefore, more understanding of the processes that influence the soil solutes transport in the root zones is still needed. My study focuses on the analysis of the continuously changing “transient” and multi-dimensional processes in the root zone soils. In addition to better manage root zones salinity using the contribution of seasonal winter rainfall to the soil solute dynamics in Almond and Pistachio trees’ root zone, combined with the effects of using a lower quality of irrigation water in a drip irrigated system. Physically based modeling approach is a key instrument for predicting various dynamics and management strategies. I am using the HYDRUS numerical model (Šimůnek et al., 2008), which simulates water, solute, and energy transport in soils to analyze the transient movement of water and salts in the RZs of almond and pistachio trees. Almond and Pistachio orchards of San Joaquin Valley (SJV) in California is a current prime example of the productive agricultural loss due to salinity (Gies, 2017). Zaccaria et al., 2017 reported that pistachio and almond trees root zones (RZs) in the SJV are affected negatively by the increased accumulations of soil salts. The numerical model's simulations in this study were calibrated using continuous field measurements of the root zone soil moisture and salt concentrations at five drip-irrigated almond and pistachio orchards in the San Joaquin Valley (SJV), CA. Measurements were collected from three locations of each site at soil depths 0 -120 cm. This study data was collected for two consecutive winter seasons and another two consecutive summer seasons. The simulated outputs were used to quantitatively identify the effect of the seasonal wet and dry rainfall seasons, and the increased salinity of irrigation water during the different seasons on the RZ total salt concentrations and the cumulative root zone leaching/drainage dynamics.

Development and applications of the soil water-isotope models

Tiantian Zhou

Major Professor: Jirka Šimůnek

Water transformation at the interfaces of the GSPAC system (Groundwater-Soil-Plant-Atmosphere Continuum, GSPAC) is a key topic of the field water cycle research and represents a theoretical basis for improving the water use efficiency. The determination of groundwater recharge and evapotranspiration, and the quantification of their water sources is a challenge in the research of interface water transformations. In this project, we used experimental observations, isotope tracing techniques, and simulation methods for addressing this research topic. HYDRUS-1D and the Craig-Gordon model will be combined to develop the water-isotope transport modules to account for fractionation effects during evapotranspiration for different climate zones. These new water-isotope modules will be verified by comparing their results with the results of analytical solutions and with experimental data involving variations of water contents and isotopic compositions in the GSPAC systems of both North China Plain (sub-humid zone) and Northwest China (arid zone). These new water-isotope modules will then be used to evaluate the influencing mechanisms of rainfall/irrigation and groundwater level on water transformation of the GSPAC interfaces. Additional scenarios simulation and sensitivity analyses will be carried out. This research will lead to a better understanding of dynamic processes involving rainfall/irrigation infiltration, soil moisture change, evaporation, transpiration, and groundwater recharge. This study will also provide process-based scientific basis for efficient utilization of agricultural water resources.

Understanding the Future of California's Largest Lake: Utilizing SWAT to Establish a Regional Water Balance for a Highly Managed Watershed

Aarushi Jha

Major Professor: Hoori Ajami

Physically based hydrologic models are powerful tools for simulating watershed response to changing management practices and climate change. The Soil and Water Assessment Tool (SWAT) is a physically based, semi-distributed model that is widely used for simulating hydrologic fluxes at a watershed scale. However, currently there is no established method for representing large lakes in many hydrologic models including SWAT. Limitations are associated with the automated watershed delineation algorithm and inaccuracies in constraining lake parameters using a discrete 'reservoir' point located along a stream. The Salton Sea is a terminal lake in a 21,000 km^2 arid, agricultural watershed located in Southern California and Mexico, with annual rainfall of 76 mm. Increased agricultural water use efficiency and reduced Colorado River inflows to surrounding agricultural areas have decreased runoff to the lake, decreasing lake area and raising air quality concerns from exposed lake playa. In this study, we design a method in SWAT to represent the Salton Sea and quantify changes in lake area in response to changes in Colorado River allocations and climate forcing. To achieve this objective, we represent the Salton Sea by 1) assigning land use as 'Water' for a subbasin delineated to the lake's area, and 2) routing lake inflows to a series of 'reservoirs' within the subbasin. We explicitly delineate the All-American Canal in our simulations and represent other canals and drains using model specific parameterization. Model performance is initially evaluated through calibration and validation against streamflow data. Other observational data including groundwater and remotely sensed evapotranspiration will be incorporated for future evaluation of model performance. Results will inform development of a method to incorporate lake and agricultural hydrologic processes in a regional watershed model and improve management practice in a highly managed watershed.

Air quality and environmental justice in the United States: who pays for pollution?

Yaning Miao

Major Professor: William Porter

Air quality is spatially heterogeneous, with regional differences driven primarily by local and synoptic factors including differences in natural and anthropogenic emissions, meteorology, and topography. The spatial patterns of air pollution can also show correlations with socioeconomic indicators such as poverty, employment and education. To investigate these connections, we examine regional and seasonal patterns of observed fine particulate matter ($PM_{2.5}$), coarse particulate matter (PM_{10}) and ozone (O_3) along with county-level metrics for poverty, population density, employment and education across the United States. We then compare observed patterns and socioeconomic differences with those produced by the chemical transport model GEOS-Chem to assess the ability of the model to reproduce observed patterns at a national scale. Finally, we examine pollution and health disparities around the Salton Sea region as a local case study, investigating the potential connections and feedbacks between socio-economic status, pollution, and health outcomes.

DMS oxidation and urban coastal air quality

Linia Tashmim

Major Professor: William Porter

Oceanic emission of dimethyl sulfide (DMS) and halogenated species have a non-negligible impact on the composition and mass of fine particulate matter ($PM_{2.5}$) and aerosol acidity, as well as on the concentration of ozone (O_3), a gas-phase criteria pollutant. All of these changes can affect the overall air quality of the marine troposphere, as well as over coastal cities near these oceanic sources of pollutant precursors. Once DMS is in the atmosphere it oxidizes to form SO_2 and methane sulfonic acid (MSA). This SO_2 can be further oxidized leading to the formation of sulfate aerosol at a rate linearly correlated with aerosol acidity. However, in most air-quality models the oxidation mechanism of DMS in the troposphere is highly simplified and neglects the significant interaction between DMS and tropospheric oxidants ozone (O_3) or halogenated species like bromine oxide (BrO). This simplification leads to uncertainty in the global DMS burden and could be also be a reason for the overestimation of SO_2, MSA and sulfate abundance in the pre-industrial environment. The gas phase oxidation reaction of DMS can also affect new particle formation further influencing local air quality and climate. Through this research I investigates the connection between air quality and DMS oxidation in the marine troposphere using a newly implemented series of gas-phase and multiphase sulfur oxidation mechanisms into the Goddard Earth Observing System with Chemistry (GEOS-Chem) global chemical transport model. Using this mechanism which includes the addition of two important intermediates, dimethyl sulfoxide (DMSO) and methane sulphinic acid (MSIA), it is possible to reduce the bias in prediction of SO_2 and MSA. This is expected to improve the modeled representation of the sulfur cycle in the global marine troposphere, as well as the prediction of air quality over coastal cities around the world.

Influence of Ammonia and Relative Humidity on the Optical Properties of Secondary Organic Aerosol Particles

Yumeng Cui

Major Professor: Roya Bahreini

To understand the radiative impacts of secondary organic aerosol (SOA) particles, it is important to know their optical properties. In this work, we investigate the impact of ammonia (NH_3) at different relative humidity (RH) levels on SOA optical properties and chemical composition. For this investigation SOA was produced by reacting 1-methylnaphthalene or longifolene, with hydroxyl radicals under variable nitric oxide, RH, and NH_3 conditions. During SOA formation, the chemical composition and optical properties of SOA were monitored. In addition, single scattering albedo (SSA), mass absorption coefficient (MAC), and refractive index (RI) of SOA at λ=375 nm were calculated.

In the presence of NH_3, longifolene SOA had relatively high SSA values and low absorption coefficients (β_{abs}) under both intermediate- and high-NO_x regimes at both low RH (<30%) and intermediate RH (45-50%). This suggests that longifolene SOA is mostly scattering. In 1-methylnaphthalene experiments, β_{abs} increased soon after initiation of the experiments under both low and intermediate RH and different NO_x regimes, suggesting the formation of light-absorbing aerosols. Comparing the optical results from experiments under different conditions, SOA formed under higher RH and NO_x were more light absorbing (with SSA≈ 0.7, MAC_{max} ≈ 0.6 m^2/g and RI k ≈ 0.025). The chemical composition of 1-methylnaphthalene SOA has also been analyzed, and the formation of possible light-absorbing component, nitrogen-containing organic compounds (NOC) has been confirmed.

Soil Carbon Dynamics after Switch to Precision Irrigation in Intact Cores of a Furrow Irrigated Orchard Soil

Claudia Avila

Major Professor: Sam Ying

Across the United States, irrigation accounts for over a third of total water withdrawals, with more than half of that water being applied as surface irrigation although only accounting for 37% of the total irrigated land acreage. In California, the most profitable agricultural state in the nation, however, roughly 80% of total water withdrawals is used for irrigation. As droughts are expected to not only be more frequent but more intense, a shift towards more precise, water saving irrigation methods (i.e. drip and micro-sprinkler irrigation) has been observed in areas where gravity irrigation still dominates. These shifts, although demonstrating positive efforts on policymakers and cultivators, have biogeochemical ramifications that have not been thoroughly explored. After an extensive multi-phase characterization of carbon dynamics from a currently furrow irrigated orange orchard of the Riverside Greenbelt, intact soil cores of regions of most frequently inundated to most dry soil were taken and manipulated in a controlled laboratory setting. The soil moisture of these soils was then matched to soil moisture sensor data collected from a site within the region using micro-sprinkler irrigation to imitate in situ conditions. The soil gas phase was then measured for CO_2 flux, N_2O, and methane. The CO_2 flux data of each of the soils were then compared to the pre- and post- irrigation events from in-situ measurements taken at the field site currently using furrow irrigation.

Greenhouse Gases and Ammonia Emissions from Two Dairy Farms in California

Valerie Carranza

Major Professor: Francesca Hopkins

Dairies contribute to a substantial amount of greenhouse gas (GHG) and ammonia (NH_3) emissions in the state of California. State legislation is in place to reduce GHG emissions to 40% below 1990 levels by 2030. However, there is disagreement between atmospheric observations and statewide inventories over the magnitude of methane (CH_4) emissions from dairy manure management. Quantifying and characterizing GHG emissions from dairy farms are essential for source apportionment and to evaluate the effectiveness of emission control strategies. In this study, we present atmospheric measurements at two California dairies with contrasting manure management practices in the San Joaquin Valley (SJV) and in Southern California taken in Fall 2018 and Spring and Summer of 2019. At the SJV dairy, CH_4 fluxes from dairy anaerobic lagoons were estimated using dispersion modeling and tracer-tracer correlations were used to characterize emission signatures from distinct sources including livestock housing (e.g., corrals), manure management (e.g., lagoons), silage piles, and liquid manure-irrigated cropland. We find that ΔNH_3:ΔCH_4 ratios from livestock housing are about an order of magnitude higher than those from manure, whereas ΔCH_4: ΔCO_2 ratios from wet manure are more than 20 times higher than from livestock housing. ΔN_2O:ΔCH_4 correlations also show distinct signatures between sources. Manure management areas were distinguished by relatively enriched $\delta^{13}CH_4$ compared to livestock housing. At the Southern California dairy, we explored different techniques to estimate CH_4 fluxes from lagoons: 1) dispersion modeling of 10-minute stationary CH_4 mole fractions collected around manure lagoons paired with micrometeorological measurements, 2) vertical fluxes using eddy covariance, and 3) floating chamber measurements. The results from this study can improve CH_4 emission estimates from dairies, spatial allocation of GHG and NH_3 emissions at the dairy-farm scale and constrain the relative contributions of these different sources of emissions to overall dairy farm emissions.

Top-Down Methane Emission Estimates from California Dairies by Solar Column Gradient Observations

Isis Frausto-Vicencio

Major Professor: Francesca Hopkins

The dairy industry in California is an important and growing source of methane (CH_4) and contributes nearly 50% of total statewide emissions. State-based efforts for emission reduction are underway, however, the magnitude of the dairy CH_4 source is highly uncertain. We used two portable EM27/SUN solar-viewing Fourier-transform infrared (FTIR) spectrometers placed at upwind and downwind locations of dairies to measure gradients in total column methane (ΔX_{CH4}). We observed regional enhancements downwind of a dense region with 30 dairy farms housing >30,500 cows in the San Joaquin Valley (SJV) (~20x20 km^2) and used it to estimate CH_4 emissions. We deployed the FTIR instruments during three seasons (Fall, Spring, and Summer) and performed atmospheric flux inversions using the back-trajectory transport model, WRF-STILT. We find the observed ΔX_{CH4} range from 10 to 60 ppb, more than three times as large as the enhancements observed from the Chino area dairies in Southern California and comparable to the mean enhancement from Four Corners, NM. This illustrates the size and importance of the SJV dairy CH_4 source. Preliminary analysis suggests a mean of 35 ppb ΔX_{CH4}, a seasonal variation dependent on climate factors such as wind speeds, and a diurnal cycle driven by wind directional shifts. We compare observed emissions to WRF-STILT modeled estimates driven by a temporally static emission prior. Initial comparison suggests inventories underestimate emissions by a factor of 2 in our study site. This study will help constrain CH_4 emissions from California dairies and assess the effectiveness of mitigation efforts to reduce greenhouse gases.

Source Attribution of Methane Point Source Emissions using Airborne Imaging Spectroscopy and the Vista-California Methane Infrastructure Dataset

Talha Rafiq

Major Professor: Francesca Hopkins

On a molecular basis, methane (CH_4) has a radiative forcing potential far higher than carbon dioxide. In the state of California, CH_4 emitting infrastructure has shown to significantly contribute to greenhouse gas emissions. Combined with airborne atmospheric observations, this study hopes to improve CH_4 emissions estimates for California. Airborne campaigns using the next-generation Airborne Visible/Infrared Imaging Spectrometer (AVIRIS-NG) measured CH_4 plumes at a spatial resolution of between 1 and 3m spatial resolution. AVIRIS-NG detected 1,181 individual CH_4 plumes across California as part of the 2016 – 2017 California Baseline Methane Survey. Some observed sources included gas storage facilities, hydrocarbon storage tanks, landfills, dairy lagoons, and pipeline leaks. We developed the Vista-CA geospatial database that contains a library of 900,000 validated potential methane emitting infrastructures that are based on the framework established by the Intergovernmental Panel on Climate Change (IPCC) (Carranza et al. 2018). We also have developed a complimentary algorithm to allocate individual CH_4 point sources identified by AVIRIS-NG to Vista-CA CH_4 infrastructures for source identification and assessment. This work illustrates both the capabilities of the Vista-CA CH_4 database for source apportionment analysis, the investigation of IPCC sectoral emission trends, and an advancement in automated CH_4 attribution. AVIRIS-NG airborne CH_4 retrievals combined with the geospatial capabilities of Vista-CA through an automated geospatial system permit locating and identifying point sources to improve confidence in sectoral source attribution and aid mitigation efforts.

Land Application of Dairy Manure Biochar Reduces CO_2 & N_2O Emissions from Two Different California Dairy Soils at Ambient & Elevated Temperatures

Michael Rodriquez

Major Professor: Francesca Hopkins

The pyrolysis of dairy manure and land application as biochar may allow for emissions offsets while contributing to soil health through its high carbon stability, soil fertility properties, and possibly reduce GHG emissions. In a 36-day incubation experiment, two California dairy (Riverside & Tulare county) soils were applied with either solid sun-dried dairy manure, manure derived biochar, or no amendment at ambient temperature (23℃) & elevated temperature (28℃). CO_2 and N_2O fluxes were measured using cavity ringdown spectrometers in a closed system and soil was sampled for total carbon, total nitrogen, and moisture content. Overall, more CO_2 was emitted from the Riverside county dairy soil while much more N_2O was emitted from the Tulare county soil. At ambient temperature, normalized CO_2 emissions decreased by 62% & 77% while normalized N_2O emissions decreased by 80% & 87% for the Riverside and Tulare soils respectively when manure biochar was applied instead of the dried manure. At the elevated temperature, normalized CO_2 emissions decreased by 55% & 73% while normalized N_2O emissions decreased by 64% & 75% for the Riverside and Tulare soils respectively when biochar was applied instead of the manure. CO_2 emissions increased significantly under elevated temperatures while N_2O emissions were not affected by temperature. However, CO_2 emissions from the Riverside soil did not increase with temperature when amended with biochar, showing its viability as a long-term carbon management strategy while reducing N_2O emissions. Future work will focus on mechanisms contributing to emissions as wells as experimenting with other organic waste amendments.

Advancing agricultural and landscape irrigation to increase water use efficiency

Anish Sapkota

Major Professor: Amir Haghverdi

Irrigated agriculture and landscape are among the largest consumers of available freshwater in the western USA. Precision irrigation which takes account of various within-field heterogeneity including variable evapotranspiration, soil moisture content, vegetation, and land cover can better estimate the water requirement of the crops and landscape species. The objective of this study is to incorporate engineering and management techniques to conserve water and improve the irrigation water use efficiency while maintaining the physiologic performances of the plant species. Remotely sensed satellite images are being studied via geospatial statistical approaches to determine the potential benefits of variable rate irrigation (VRI) systems in the Southern California desert agriculture (project #1). The main hypothesis of the project #1 is that VRI has the potential to increase the irrigation water use efficiency and improve crop production by avoiding under- and over-irrigation caused by the traditional uniform irrigation. Project #2 consists of 144 fully automated irrigation research plots (12 landscape species × 4 irrigation treatments × 3 replications) where evapotranspiration-based smart controllers are utilized to impose autonomous demand-based full to deficit irrigation scenarios. The main hypothesis of the project #2 is that smart controllers can reduce the urban water-use through demand-based landscape irrigation. Various handheld sensors are in use to evaluate the effects of varying rates of irrigation treatments on the physiologic performance of the landscape species. Additionally, a UAV-mounted multispectral camera is used to study the physiologic performance of the landscape species. The efficacy of UAV based imagery will be evaluated for early detection of urban landscape drought injury. Overall, both projects focus on increasing water use efficiencies in the agricultural and landscape species by use of state-of-the-art smart technologies.

Landscape irrigation management using smart irrigation controllers and reliable water content estimations

Amninder Singh

Major Professor: Amir Haghverdi

Southern California is the most urbanized and populous region of the state largely dependent on the water sources from other regions. This, along with frequent droughts, increasing population, water shortages and the long-term challenge of climate change, all point to the need for efficient management of water resources. There are two constituents for sustainable management of water resources:1) accurate information about the water use for the landscape, and 2) reliable soil moisture estimations so the existing irrigation technology for efficient water management can be harnessed. About 50% of dedicated urban water use in California goes toward landscape irrigation. Turfgrass forms a major component of the landscapes planted in recreational fields, golf courses, public parks and residential areas where irrigation with recycled water has gained attraction because of its availability. Recent advancements in irrigation technology can help optimize the use of limited water resources while maintaining acceptable turfgrass quality.

In our study, smart irrigation controllers were used to imposing multiple irrigation treatments ranging from control/full to several deficit irrigation scenarios using potable and recycled water. An artificial neural network-based pedotransfer function (PTF) was also developed using a comprehensive soil hydrological dataset to estimate water content at any predefined matric head. Soil water characteristics were measured using evaporation-based methods in this dataset which result in high resolution data points. The data obtained from both parts of the study will be analyzed to develop recommendations and management tools for efficient landscape irrigation, and some preliminary results will be presented in this talk.

Estimating Riverine Microplastic Flux by Accounting for Transport Dynamics

Win Cowger

Major Professor: Andrew Gray

Abstract: Sampling microplastics at the surface of a stream in order to derive average concentrations and estimate microplastic loading without recognition of hydrologic processes is misguided. These methods were adapted from oceanic sampling and are employed for ease rather than representative sampling. Surface sampling assumes equal concentration of microplastics within the water column. It is well known in the field of fluvial sediment transport that non-buoyant particles will display increasing dependence of concentration on depth with increasing particle size and decreasing turbulent fluctuations (i.e. shear velocities) in the flow field, a phenomenon commonly approximated by the Rouse profile. Here we apply to the same approach to particles spanning the negative to positive buoyant characteristics in water of commonly found plastic compounds. Using a one-dimensional Rouse profile approach, we show that surface sampling methods can introduce up to eight orders of magnitude uncertainty in any assessment of average concentrations. This uncertainty is primarily due to a wide range of plastic polymer types with diverse shape factors and densities that strongly vary in their concentration-depth profiles. For example, many polystyrene products have densities lower than water with near-surface concentration maxima, so estimations using near-surface discharge as opposed to full discharge are more accurate. These results indicate that in order to effectively monitor fluvial microplastic transport we need to assess the hydrologic mechanisms that affect our measurements, correct for them in our reporting of abundance, and develop new methods for assessing the concentration depth profile of microplastics in streams.

Seasonal shift of post-fire sediment provenance from channels to hillslopes documented through high-resolution monitoring

James Guilinger

Major Professor: Andrew Gray

Wildfire is a highly effective short-term disturbance agent in semi-arid mountainous settings, where runoff and associated sediment yields may increase by orders of magnitude during the first few post-fire storm events. This brief period represents a critical time for downstream stakeholders, when understanding the threat from sediment-laden flows to receiving water resources and infrastructure during intense rainfall is crucial. Previous work has shown that storm type and sequencing are important controls on the dominant erosive processes and associated sediment pools feeding sediment-laden flows, but the mechanisms behind this are still poorly understood. In this study, we seek to understand how storm runoff magnitude and sequence affects sediment availability and transfer from hillslopes to channelized domains where material may be stored or exported downstream.

In order to achieve this, we monitored surface changes, precipitation, soil moisture, and runoff over the course of the first wet season following wildfire in a steep (>32 degrees) ~1 ha watershed burned by the 2018 Holy Fire in Southern California. Change detection was performed using sequential terrestrial lidar scanning and UAV-based structure from motion. The first effective events occurred four months following the burn and generated extensive erosion with sediment yields equivalent to ~190 m^3/ha with slightly more than half of this sediment derived from channelized erosion through gully formation. The next change detection sequences bracketed storms with more sustained rainfall intensities that yielded greater runoff at the hillslope plot scale with commensurate increases in shallower hillslope sediment yields relative to channels. These results indicate that amplified runoff from earlier, lower magnitude storms was sufficient to evacuate channels, while hillslopes persisted as a sediment source for sediment-laden flows later in the post-fire wet season. Predictive models of post-fire sediment export would be improved by more explicitly incorporating the role of storm sequences in controlling sediment availability in channels and on hillslopes.

The Role of Wildfire in the Long-term Suspended Sediment Yield of Small Mountainous Rivers

Nathan Jumps

Major Professor: Andrew Gray

Wildfires can impose a substantial perturbation to watershed function through the removal of vegetation and alteration of soil physical properties that tend to increase water and sediment supply to the channelized system. This can result in dramatic increases in watershed sediment yield relative to pre-burn conditions, particularly during intense rainfall on small mountainous watersheds over the months to years immediately following a burn, before vegetation and landscape stability recover. However, the relative contribution of wildfire to long-term (inter-decadal to millennial time scale) watershed sediment yield is still a subject of debate, even in small mountainous systems. The objective of this study was to evaluate changes to suspended sediment concentration-discharge relationships in a burned 587 km^2 catchment caused by wildfire and examine their potential role in determining long-term sediment flux rates. In December of 2017, the Thomas Fire consumed a reported area of 1,140 km^2 along the eastern end of the Santa Ynez Range, including 82% (481 km^2) of the Ventura River watershed. We monitored suspended sediment concentrations during stormflow events in the Ventura River at Foster Park (USGS Gaging Station 11118500) during water years 2018 and 2019, and characterized post-wildfire suspended sediment concentration-discharge relationships, which were then compared with pre-fire suspended sediment dynamics characterized by the USGS from 1908 to 2015. Preliminary results show that post-wildfire storm flows resulting from short duration high intensity rainfall events bore concentrations of suspended sediment over an order of magnitude higher than pre-fire concentrations. Rainfall intensity and elapsed time since the wildfire were found to be more informative for predicting post-wildfire sediment concentrations than discharge alone. Suspended sediment flux from the Ventura River watershed during the two years following the Thomas Fire were nearly ten times greater than mean pre-fire conditions. Sediment flux increases appear to have been primarily driven by increases in sediment supply rather than increases in storm runoff partitioning. Considering the return frequency of wildfire in the California Transverse Ranges, wildfire appears to be a dominant mechanism for long-term sediment transfer.