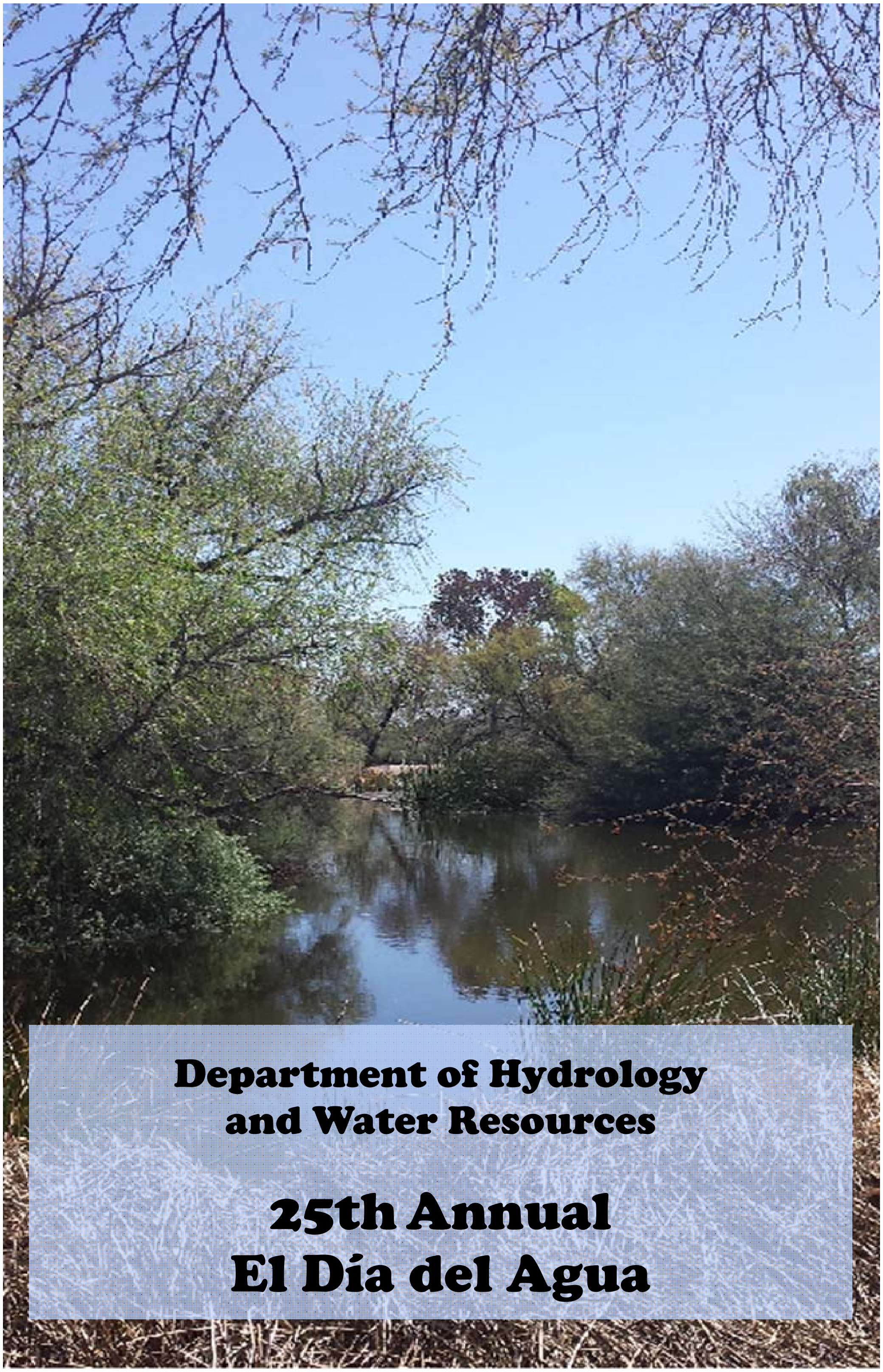
Department of Hydrology
and Water Resources
25th Annual
El Día del Agua

THE UNIVERSITY OF ARIZONA

Department of Hydrology and Water Resources

25th Annual
El Día del Agua

April 8, 2015
Student Union North Ballroom

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Message from HWRSA

Welcome! On behalf of the Hydrology and Water Resources Student Association (HWRSA), we would like to welcome you to the 25th Annual El Día del Agua Student Research Symposium. The annual symposium was established by our student body in 1990 and continues to be organized and managed by our students.

El Día del Agua is the perfect opportunity for students to present their current research in the University of Arizona's Department of Hydrology and Water Resources (HWRS), a department known worldwide for its cutting-edge research in hydrology and related sciences. El Día del Agua is one of five symposia held during EarthWeek 2015, a joint conference organized by the School of Earth and Environmental Sciences.

As a joint conference, EarthWeek enables students to meet and network with their peers, faculty members from across campus, alumni, and other working professionals from the water community which strengthens the ties among these groups. These events also promote career and professional development through informal meetings and presentations by visiting alumni and other potential employers to students interested in water-related careers.

El Día provides a great opportunity for prospective students to learn more about the wide range of research opportunities available to HWRS students. Many student presenters you will hear and meet today had their first introduction to the department at a past El Día del Agua!

The success of El Día is made possible through the continued support of our sponsors and to the time, dedication, and effort of HWRS faculty, students, and staff members, as well as our colleagues in the School of Earth and Environmental Sciences.

Thank you for taking the time to help us celebrate El Día del Agua. We hope you enjoy the day with us!

Hydrology & Water Resources Student Association Officers AY2014-2015

Back row (behind sign), left to right: Dr. Thomas Meixner, Faculty Mentor; Rodrigo Andres Sanchez, Treasurer; Antonio Meira Neto, President. *Front row, left to right:* Rajarshi Mukherjee, Social Chair; Marlyn Ripalda, Undergraduate Representative; Alissa White, Social Chair; Katarena Matos, Undergraduate Representative; and Tirthankar Roy, Vice President.

El Día del Agua
Morning Schedule

8:00-8:55 **Register/Check-in and Breakfast**
Student Union Memorial Center, North Ballroom

8:55-9:00 **Welcome Dr. Larry Winter**, Professor and Department Head, Hydrology and Water Resources, and **Antonio Meira Neto**, President, Hydrology and Water Resources Student Association for AY2014-2015

9:00-10:00 **Oral Presentations** Moderator, **Alissa White**

9:00-9:20 Derek Groenendyk, Visualizing soil texture: Is there a better way?

9:20-9:40 Ni Yan, Feasibility of in situ chemical oxidation (ISCO) of 1,4-dioxane and trichloroethene co-contamination: A laboratory study

9:40-10:00 Rajarshi Mukherjee, Implications of statistical and dynamical downscaling methods on hydrological projections for the Colorado basin

10:00-11:00 **Poster Session**

11:00-12:00 **Oral Presentations** Moderator, **Daniel Ritter**

11:00-11:20 Alissa White, Impacts of wildfire on throughfall and stemflow precipitation chemistry and flux

11:20-11:40 Jacob Knight, Use of an integrated hydrologic model to assess the effects of pumping on streamflow in the lower Rio Grande

11:34-12:00 Ravindra Dwivedi, Lava lamp to flow in fracture-water to fracture-porous media: Unity in physics but diversity in implications

El Día del Agua
Afternoon Schedule

12:00-1:30 **Buffet Luncheon & Luncheon Speaker** (South Ballroom) **Dr. Thomas Meixner**, Professor & Associate Department Head, HWRS, and El Día del Agua Co-Chair: Introduction to the Luncheon Speaker, **Dr. Robert Harrington**, Director, Inyo County Water, and HWRS Alumnus, who will present *Groundwater management in Owens Valley, California: The Red Queen meets the California Environmental Quality Act.*

1:30 - 2:30 **Oral Presentations** Moderator, **Ben Paras**

1:30-1:50 Zhao Yang, Urban effects on regional climate, water, and energy demand: A case study in the Phoenix and Tucson corridor

1:50-2:10 Colin Kikuchi, Analysis of subsurface temperature data to quantify groundwater recharge rates in a closed altiplano basin, northern Chile

2:10-2:30 C. Michael Tso, Hydraulic tomographic surveys with flux conditioning in stationary and non-stationary layered aquifer systems

2:30-3:30 **Poster Session**

3:30-4:30 **Keynote Lecture** (North Ballroom) **Dr. Larry Winter**, Professor and Department Head, HWRS, and El Día del Agua Co-Chair: Introduction to the Keynote Lecturer, **Dr. Wenke Wang**, Dean, School of Environmental Science and Engineering, Chang'an University, Xi-an, China, who will present *Vadose zone hydrology and eco-hydrology in China.*

4:30-5:15 **Presentation of Awards and Prizes** — MC, **Alissa White**
Montgomery Prize by **Brittney Bates**
Hargis Awards by **Leo Leonhart**
HWR Excellence Awards by **Larry Winter**
Donald Davis & Eugene Simpson Awards by **Tom Meixner**
AquaMan-AquaWoman Award by **Antonio Meira Neto**

5:30 **Reception & Social Hour** at Auld Dubliner for all El Día del Agua attendees, students, faculty, and visitors

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2014-2015 Members

The Department Advisory Council (DAC) was organized in 1991 and is comprised on HWR alumni and other colleagues from private industry and consulting, government agencies, and academia world-wide, including Principals, CEOs, CFOs, university-level faculty members, and research scientists in national laboratories.

Daniel B. Stephens, *Chair*
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WESTWATER, LLC, Phoenix, Arizona

Don Zhang
Peking University, Beijing, China

Awards and Prizes
Evaluation Committees

Students are recognized for their superior achievement in oral and poster presentations by juried committees. We are most grateful to the Judges for volunteering their time and expertise in selecting award winners. Their energy, enthusiasm, and constructive feedback inspire us all to achieve our personal best.

Montgomery Prize

Best Oral Presentation
Certificate and Award of $2,000
Judges: Brittney Bates, Luke Pangle, Xavier Zapata-Rios

Hargis Awards

Best Technical Presentation via Visual Communication
First Place Poster, Certificate and Award of $1,000
Second Place Poster, Certificate and Award of $400
Judges: Damian Gosch, Leo Leonhart, Dennis Scheall

HWR Awards of Excellence

Best Oral and Poster (excluding Montgomery and Hargis winners)
Certificate and Award of $400 for each award
Judges: *Oral,* Chris Magirl, Till Volkman, Martha Whitaker; *Poster,* Tim Corley, Matej Durcik, Greg Leonard, Mark Thomasson, Jim Washburne

Donald R. Davis Undergraduate Distinction Award

Outstanding Undergraduate Award (Academic or Research)
Certificate and Award of $400
Judges: Antonio Meira, Tirthankar Roy, Alissa White

Eugene S. Simpson Undergraduate Poster Award

Best Undergraduate Poster in Hydrogeology, Subsurface Hydrology, or Groundwater
Certificate and Award of $400
Judges: Antonio Meira, Tirthankar Roy, Alissa White

The Montgomery Prize

We would like to thank Errol L. Montgomery & Associates, Inc., a

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for their support of the 25th Annual El Día Del Agua. For many years, Montgomery & Associates has sponsored the premier cash award, *The Montgomery Prize*, for the Best Oral Presentation at our annual student research symposium.

This "best of the best" prize is made in addition to the departmental Awards of Excellence for best oral and best paper presentations and is presented to the winner by a representative from Montgomery & Associates. The award symbolizes the company's commitment to encouraging and rewarding excellence in oral presentation of hydrologic research. Montgomery & Associates offers similar awards during annual events at the University of Arizona and Northern Arizona University Geology Departments.

Errol L. Montgomery & Associates, Inc., founded by HWRS Alumnus Errol L. Montgomery, is a water resource consulting group with more than 25 years of experience addressing groundwater availability, sustainability, and quality issues for municipal, industrial, mining, and governmental clients. Professional services include:

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The firm's principal office is located in Tucson, Arizona, and branch offices are maintained in Scottsdale, Arizona, Lima, Perú, and in Santiago de Chile.

The Hargis Awards

We would like to thank Hargis + Associates, Inc., a

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for their support of the 25th Annual El Día del Agua. For many years, Hargis+Associates has sponsored two generous cash awards, The Hargis Awards, for the First and Second Place Best Poster Presentations at our annual student research symposium.

Evaluation of these awards is performed by a panel selected by HWR Alumnus Dr. David Hargis, President and CEO of Hargis+Associates, Inc., in San Diego, California. Hargis and his fellow HWRS Alumnus Dr. Leo Leonhart, Principal Hydrogeologist and Chief Technical Director, Hargis+Associates, Inc., in Tucson, annually present these awards. The Hargis Awards are made in recognition of the need for excellence in technical communication and serve as an incentive for participating students to demonstrate excellence in writing, visual presentation, and oral communication skills in support of their research projects.

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Hargis+Associates, Inc., established in 1979 by HWRS Alumnus David Hargis, is an environmental consulting firm specializing in hydrogeology and engineering. The company is headquartered in San Diego, California, and has offices in Mesa and Tucson, Arizona. Practice areas include all aspects of hydrogeology and environmental engineering focused in the following markets:

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Donald R. Davis
Undergraduate Distinction Award

Donald R. Davis joined the UA Department of Hydrology and Water Resources in 1972 and was one of the most senior members of the faculty at the time of his death in February 2009. His primary research focus was decision making under hydrologic and other uncertainties, and his basic approach utilized Bayesian decision theory in a general system setting.

During the last decade of his life, even though the halcyon days of funded research were behind him, Don was still actively engaged in independent statistical studies with individuals both inside and outside the university. He continued to serve on MS and PHD exams and to advise masters and especially doctoral students who were majoring or minoring in Hydrology with the statistical aspects of their research projects. He was an active faculty examiner for the doctoral qualifying examinations in surface hydrology and water resources.

Don served as the Undergraduate Coordinator and was the primary advisor to undergraduates with a major or minor in Environmental Hydrology and Water Resources. He taught the year-long Senior Capstone and Senior Honors Thesis courses and, when the department was part of the College of Engineering, was a rotating instructor for the COE's freshman course, Engineering 102. With Gary Woodard, he designed and oversaw the Master of Engineering degree program in Water Resources Engineering and helped that fledgling program get off the ground.

Upon his death, he left an endowment to the Department of Hydrology and Water Resources specifically for undergraduates whom he especially supported and encouraged.

The evaluation for the Davis Undergraduate Distinction Award is made by a committee appointed by the department and recognizes an outstanding undergraduate who demonstrates excellence in writing, speaking, or technical communication or provides outstanding service through volunteerism or extracurricular activities that benefit the department or the profession.

Don will be remembered not only for his academic and advising contributions, but also for his love of the undergraduate program he nurtured.

Eugene S. Simpson
Undergraduate Poster Award

Eugene S. Simpson began his professional career with the U.S. Geological Survey in 1946 where he was involved with problems of migration and dispersion of radioactive wastes that might accidentally or operationally be discharged into groundwater.

In 1963, he was hired by Dr. John W. Harshbarger as a member of HWR's inaugural faculty, and he continued to pursue his research interests in aquifer mechanics, the migration of pollutants in groundwater, and the application of environmental tracers to problems of groundwater circulation. Simpson served as HWR Department Head from 1974-75 and 1979-81.

After his retirement in 1985, he remained active in the profession, serving the U.S. Chapter of the International Association of Hydrogeologists as Secretary-Treasurer from 1984-89 and as President from 1989-92. During his tenure as President, he became the Founding Editor and first Editor-in-Chief of the IAH journal, *Applied Hydrogeology*, which later became *Hydrogeology Journal* (Springer), the official journal of the IAH.

The Geological Society of America Hydrogeology Division honored him with the Distinguished Service Award in 1992, and the International Association of Hydrogeologists elected him an Honorary Member in 1993.

Following retirement, he resided in Tucson until his death at the age of 78 in December 1995. At that time, the Eugene S. Simpson Endowment was established to provide financial support for undergraduate and graduate students, especially those studying hydrogeology and subsurface hydrology.

In March 2012, the inaugural Eugene S. Simpson Undergraduate Poster award was made for the best undergraduate poster with priority given to hydrogeology, subsurface hydrology, or groundwater content, Simpson's areas of expertise. Evaluation for the award is made by a committee appointed by the department.

The department would like to thank the family, friends, and former students of Eugene S. Simpson for their continued support and contributions to this endowment fund.

El Día Del Agua
Luncheon Speaker

Dr. Robert Harrington
Director, Inyo County Water
Independence, California

Bob Harrington earned degrees in geophysics and hydrology/ hydrogeology from the University of Nevada – Reno and a doctorate in hydrology from the University of Arizona in 1997. His dissertation research focused on the amount and fate of acid deposition in the Sierra Nevada, California.

Harrington has worked for seventeen years as a hydrologist and department director for the Inyo County Water Department. The principal focus of his work has been monitoring and evaluation of effects of groundwater extraction on groundwater dependent habitat, and development of projects to mitigate for negative effects of groundwater pumping.

Groundwater management in Owens Valley, California: The Red Queen meets the California Environmental Quality Act

The first large regional water transfer project in the southwestern US was the Los Angeles Aqueduct (LAA), constructed in 1913, to transfer water from the east slope of the Sierra Nevada to the City of Los Angeles. The LAA was the first of a series of water transfer projects designed to supply southern California with water from the Colorado River and northern California. To keep pace with burgeoning development in southern California, in 1970, Los Angeles enlarged the capacity of the LAA by constructing a second parallel aqueduct from Owens Valley to Los Angeles. In 1972, Inyo County sued Los Angeles claiming that Los Angeles had not complied with the California Environmental Quality Act (CEQA) and that the operation of the second aqueduct would have negative environmental impacts on Owens Valley. Protracted litigation ensued, and was settled in 1991 through an agreement between Inyo County and Los Angeles that provided for joint water management in Owens Valley, joint monitoring of hydrologic and environmental conditions, and mitigation for impacts that occurred 1970 through 1990 due to Los Angeles's operation of the second aqueduct. The management prescriptions of the Inyo/LA Water Agreement are concerned primarily with preventing negative impacts to groundwater-dependent habitat from groundwater pumping. Since 1990, Los Angeles and Inyo County have managed groundwater to protect groundwater-dependent habitat in Owens Valley while providing water to Los Angeles, mitigated effects of groundwater pumping, and monitoring conditions to assess effects of water management. Groundwater pumping is managed based on available soil water and plant water needs at monitoring sites. An extensive hydrologic and vegetation monitoring program assesses the ongoing effects of pumping. Mitigations for past pumping impacts include habitat restoration, re-irrigation of abandoned agricultural lands, recreational facilities, and re-vegetation projects.

El Día Del Agua
Keynote Lecturer

Dr. Wenke Wang
Dean, School of Environmental Science and Engineering
Chang'an University, Xi'an, China

Professor Wenke Wang, born in 1962, is currently Dean of the School of Environmental Science and Engineering, at Chang'An University, China.

He obtained his Ph.D. in hydrogeology from Xi'an College of Geology in 1994 and worked as postdoctoral researcher at Changchun University of Geology from 1994 to 1996. In 2008, he was a visiting professor at the University of Nebraska-Lincoln (U.S.) for one year.

Currently, he is the Director of the Key Laboratory of Subsurface Hydrology and Ecological Effects in Arid Regions at the Ministry of Education, China, and Director of the Engineering Research Centre of Groundwater and Eco-environment of the Shaanxi Province, China.

He is an elected Foreign Academician of the Russian Academy of Engineering. In addition, Professor Wang is an editorial board member of 6 national journals, a member of the American Geophysical Union and the International Association of Hydrologists, and a panel member of the National Natural Science Foundation of China (NNSFC).

Professor Wang's research interests include groundwater numerical simulation, especially the finite analytical numerical simulation methodology; interaction between stream and groundwater; moisture and pollutants transportation and transfer mechanisms in the unsaturated zone in arid regions; recirculation, evolution, ecological-concern, and development of groundwater at the basin scale, as well as the flooding storage in groundwater regulation and control.

He has established two in-situ research demonstration trial sites with a scale of 1 and 2 hectares, respectively, which have attracted external research collaborators from about 20 countries, including the U.S., Germany, the Netherlands, Australia, and Ireland.

Professor Wang has been the Principal Investigator for more than 60 research projects, including the key project of the NNSFC and a number of national and provincial projects. He is the author of 120 research papers and has served as editor of 8 books. He has received a series of awards for excellence in teaching and research, including national and provincial awards for scientific and technological advancement. He owns 10 invention and utility patents.

Vadose zone hydrology and eco-hydrology in China

Vadose zone hydrology has long been a concern regarding groundwater recharge, evaporation, pollution, and the ecological effects induced by groundwater and water and salt contents in the unsaturated zone. The greater difference between day and night temperatures in arid and semi-arid areas influences water movement and heat transport in the vadose zone, and further influences the water and heat fluxes between the water table and the atmosphere as well as ecological environment.

Unfortunately, these studies are lacking in a systematic viewpoint in China. One of the main reasons is that the movement of water, vapor and heat from the surface to the water table is very complex in the arid and semi-arid areas. Another reason is lack of long term field observations for water content, vapor, heat, and soil matrix potential in the vadose zone.

Three field observation sites, designed by the author, were set up to measure the changes in climate, water content, temperature and soil matrix potential of the unsaturated zone and groundwater level under the different conditions of climate and soil types over the period of 1-5 years. They are located at the Zhunngger Basin of Xinjing Uygur Autonomous Region in northwestern China, the Guanzhong Basin of Shaanxi Province in central China, and the Ordos Basin of the Nei Monggol Autonomous Region in north China, respectively.

These three field observation sites have different climate and soil types in the vadose zone and the water table depth are also varied. Based on the observation data of climate, groundwater level, water content, temperature and soil matrix potential in the vadose zone from the three sites in associated with the field survey and numerical simulation method, the water movement and heat transport in the vadose zone, and the evaporation of phreatic water for different groundwater depths and soil types have been well explored.

The differences in water movement of unsaturated zone between the bare surface soil and vegetation conditions were also compared.

The concept of the ecological value of groundwater and unsaturated zone is presented in arid and semi-arid regions. This ecological value can be reflected in four aspects: (1) the maintenance of base flow in streams and areas of lakes and wetland; (2) the supply of physiological water demented by vegetation; (3) the regulation of soil moisture and salt content; and (4) the stability of the eco-environment.

In addition, the threshold system between the ecological environment and multi-dimensional indices as variations in water and salt contents in the vadose zone, groundwater depth and quality as well as groundwater exploitation, are proposed in the arid and semi-arid areas.

It is expected that this research could provide a scientific basis and technological support for better understanding on the movement of water, vapor and heat in the vadose zone in arid and semi-arid areas. It will also help to maintain sustainable development of the ecological environment and utilization of water resources.

Oral Presentation Abstracts

Visualizing soil texture: Is there a better way?

Derek Groenendyk, Ty Ferré, Kelly Thorp[1], and Amy Rice[2]

Department of Hydrology and Water Resources
University of Arizona

Soils lie at the interface between the atmosphere and the subsurface and are a key component that control many processes at the Earth's surface. There is a long history for mapping soils by texture and for their use in many areas of science. Here, we show that these traditional soil classifications can be inappropriate and suggest a new approach to soil classification. Using a k-means clustering algorithm we developed an approach for soil classification based on hydrologic responses of soils. Hydrologic simulations were performed using HYDRUS1D for a wide range of soils, spanning textures identified by the USDA soil texture triangle. We compare classifications based on changes in water content near the ground surface, which we call hydrologic-process-based classifications, to those based on soil texture and as well as specific soil properties. Differences in classifications based on hydrologic response versus soil texture, demonstrate that traditional soil texture classification is a poor predictor of hydrologic response. To visualize the significance of these differences the process-based classifications were mapped onto the soil landscape using Web Soil Survey data. The spatial patterns of hydrologic response were immediately more informative. For this reason we suggest that hydrologic-process-based classifications should be used creating more appropriate classifications.

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[1]USDA - Agricultural Research Service
[2]CESEP - Colorado School of Mines

Feasibility of in situ chemical oxidation (ISCO) of 1,4-dioxane and trichloroethene co-contamination: A laboratory study

Ni Yan, Mark L. Brusseau, Hua Zhong[1], and Yake Wang[1]

Department of Hydrology and Water Resources
University of Arizona

The commonly used solvent stabilizer compound 1,4-dioxane has become a widespread environment contaminant in both surface water and groundwater Standard water treatment methods are not effective for treatment of 1,4-dioxane. In the present study, different activated-oxidation processes were investigated for improved treatment. Batch experiments were conducted to investigate the catalytic efficiency between ferrous ion (Fe2+) and base (NaOH), oxidant decomposition rates, and contaminant degradation effectiveness. For the base-activated hydrogen peroxide (H2O2) and persulfate (S2O82-) combined system, oxidant release was moderate and sustained during the entire test period of 96 hours. However, only partial (33%) degradation of 1,4-dioxane was obtained. Conversely, the oxidants were depleted within 24 hours for the Fe2+-activated system, and 100% 1,4-dioxane degradation was achieved in 4 hours. The activation and radical generation mechanisms were different between Fe2+ and base activation. The rates of degradation for TCE and 1,4-dioxane are compared as a function of system conditions. The results of this study indicate that the Fe2+-catalyzed binary H2O2-S2O82- oxidant system is effective for oxidation of the tested contaminants.

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[1]Soil, Water and Environmental Science, University of Arizona

Implications of statistical and dynamical downscaling methods on hydrological projections for the Colorado basin

Rajarshi Mukherjee, Hsin-I Chang[1], Peter A.Troch, and Christopher Castro[1]

Department of Hydrology and Water Resources
University of Arizona

Climate change prediction under various scenarios using Global Circulation Models (GCMs) have gained widespread attention in the past couple of decades. These models are either statistically or dynamically downscaled to incorporate regional effects and reduce the model bias. This study compares and contrasts the commonly used statistical downscaling methods with a new method of dynamic downscaling developed by the authors. Our dynamic downscaling methodology involves generating a Regional Climate Model (RCM) using WRF and applying a new method of bias correction that preserves the relative change in the GCM/RCM using parametric quantile mapping method. These different climate models are then used as forcings through the Variable Infiltration Capacity (VIC) model at 1/16th of a degree to generate streamflow for three catchments in the Colorado Basin. The results are then analyzed to find statistically significant changes in various hydrological signatures using both these methods, and how it would impact the current climate change projections for the Western United States.

[1]Atmospheric Sciences, University of Arizona

Impacts of wildfire on throughfall and stemflow precipitation chemistry and flux

Alissa White, Jennifer McIntosh, Thomas Meixner, Paul Brooks[1], and Jon Chorover[2]

Department of Hydrology and Water Resources
University of Arizona

The occurrence of large, stand replacing wildfires is more frequent in the western United States now than ever before. The loss of canopy cover from wildfire drastically modifies landscapes and alters ecosystems as high intensity burns replace canopies with charred branches and trunks, change soil composition and erosion processes, and affect hydrologic flow paths and water chemistry. This study investigates the effects of fire on the chemistry and flux of precipitation diverted to the forest floor as stemflow and throughfall by observing the impact of the June 2013 Thompson Ridge wildfire in the Jemez River Basin of New Mexico. Throughfall and stemflow collectors were installed beneath burned and unburned canopies in two catchments impacted by the Thompson Ridge fire. Precipitation samples collected from both burned and unburned sites during the 2014 summer monsoon season show variations across burn severity, specifically in calcium and strontium concentrations, and collector type with stemflow concentrations generally higher than throughfall and open precipitation concentrations. Tracking variations in the amount and chemistry of precipitation that interacts with burned versus unburned forest stands, as well as open precipitation, will help to quantify changes in chemical load, hydrologic routing and catchment water chemistry caused by wildfire.

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[1]University of Utah, Geology/Geophysics
[2]Soil, Water and Environmental Science, University of Arizona

Use of an integrated hydrologic model to assess the effects of pumping on streamflow in the lower Rio Grande

Jacob Knight, Thomas Maddock III, and Randal T. Hanson[1]

Department of Hydrology and Water Resources
University of Arizona

Over the last century irrigation practices in the Rincon Valley and Mesilla Basin of the lower Rio Grande have evolved into a complex setting of transboundary conjunctive use. Three major water users have appropriation rights regulated by compact, treaty, and operating rules and agreements. The analysis of complex relationships between supply/demand components and the effects of surface-water and groundwater use requires an integrated hydrologic model to track all of the use and movement of water. Models previously developed for the region relied on a priori estimates of net irrigation flux or externally-calculated landscape water budgets. The model used in this study is built in MODFLOW with the Farm Process (MF-FMP), which directly couples the surface-water and groundwater regimes through simulation of landscape processes. This allows the assessment of stream-aquifer interactions that are dynamically affected by the fulfillment of irrigation demands with fluctuating surface water supplies supplemented by groundwater pumping. MF-FMP also simulates direct uptake of groundwater by crops, an important utility for modeling a region with significant acreage dedicated to pecan orchards. The abilities and limitations of this new model are explored through scenario simulations meant to estimate streamflow depletions caused by historic pumping levels.

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[1]US Geological Survey

Lava lamp to flow in fracture-water to fracture-porous media: Unity in physics but diversity in implications

Ravindra Dwivedi, Thomas Meixner, and Paul A. "Ty" Ferré

Department of Hydrology and Water Resources
University of Arizona

It is tempting to think of water of different ages moving and mixing like solutes. But, there is one fundamental difference. Concentration can remain constant with time (e.g. during steady state transport without decay). But, water age, by definition, changes with time. This leads to unexpected differences between the transport of solutes and the progression of water age mass that can have important implications when using tracers to interpret flowpaths and residence times. I will begin by describing the use of particle tracking or a closed system approach where water flowpaths remain steady and fixed both in space and time. Then I will present methods developed by Ginn (1999) that use the standard Advection Dispersion Equation (ADE). Then, I will explain why treating transport of water age-mass as equivalent to solute transport is theoretically incorrect. Finally, through simple examples, I will demonstrate the errors that can arise when the ADE is used to model water age mass transport. To end on a positive note, I will present a new approach that correctly models water age mass transport.

Urban effects on regional climate, water, and energy demand: A case study in the Phoenix and Tucson corridor

Zhao Yang, Francina Dominguez[1], and Hoshin Gupta

Department of Hydrology and Water Resources
University of Arizona

Human activity in urban environments impacts climate from the local to the global scale by changing the atmospheric composition and impacting components of the water and energy cycles. Specifically land use and land cover change due to urban expansion, change the surface albedo, heat capacity, and thermal conductivity of the surface. Consequently, the energy balance in urban regions is different from that of natural surfaces. In this research, we apply the coupled WRF-NOAH-UCM, which includes a detailed urban radiation scheme, to evaluate the changes in regional climate that would arise due to projected urbanization in the Phoenix-Tucson corridor, in Arizona. We use the land cover data for 2005 and projections to 2050 (for areas north to Tucson from Maricopa Association of Governments (MAG) using the Red Dot Algorithm (RDA), and for areas around Tucson and South is from SLEUTH model) with historical North American Regional Reanalysis (NARR) data as the lateral boundary condition. Results show that temperature changes are well defined and reflect the urban heat island (UHI) effect within the areas experiencing LULCC. The heat index is also examined, the magnitude of change is similar to that of temperature change. Precipitation was analyzed according to both the occurrence of rainfall and to flow regime, however, no clear evidence of changes in precipitation amount or occurrence was found due to urbanization. The water and energy demand associated with the LULC_2050 suggest that such urbanization extent is unsustainable and possibly would not occur.

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[1]Atmospheric Sciences, University of Arizona

Analysis of subsurface temperature data to quantify groundwater recharge rates in a closed altiplano basin, northern Chile

Colin Kikuchi and T.P.A. Ferré

Department of Hydrology and Water Resources
University of Arizona

Quantifying groundwater recharge is a fundamental part of groundwater resource assessment and management, and is requisite to determining the safe yield of an aquifer. Natural groundwater recharge in arid and semi-arid regions comprises several mechanisms – namely, in-place, mountain-front, and mountain-block recharge. A field study was undertaken in a high altitude (altiplano) basin in northern Chile to quantify the magnitude of in-place and mountain-front recharge. Water fluxes corresponding to both recharge mechanisms were calculated using heat as a natural tracer. To quantify in-place recharge, time-series temperature data in cased boreholes were collected, and the annual fluctuation at multiple depths analyzed to infer the water flux through the unsaturated zone. To quantify mountain-front recharge, time-series temperature data were collected in perennial and ephemeral stream channels. Streambed thermographs were analyzed to determine the onset and duration of flow in ephemeral channels, and the vertical water fluxes occurring in both perennial and ephemeral channels. The results of this study show that mountain-front recharge is substantially more important than in-place recharge in this basin. The results further demonstrate the worth of time-series subsurface temperature data to characterize both in-place and mountain-front recharge processes.

Hydraulic tomographic surveys with flux conditioning in stationary and non-stationary layered aquifer systems

Chak-hau Michael Tso and Tian-Chyi Jim Yeh

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University of Arizona

Using cross-correlation analysis, we investigate if flux measurements at observation locations during hydraulic tomography (HT) surveys carry non-redundant information about heterogeneity, complementary to head measurements at the same locations. We then hypothesize that a joint interpretation of head and flux data can enhance the resolution of the HT estimates. Subsequently, we use numerical experiments to test this hypothesis and investigate the impacts of prior information such as correlation lengths, and initial mean models (uniform or distributed means) on the HT estimates in both stationary and non-stationary fields. While prior information could be useful, their influences on the estimates could be limited under certain conditions. We will generalize the conditions at which the benefits of flux measurements during HT are limited, and provide some recommendations for conducting HT surveys and analysis.

Poster Presentation Abstracts

Conceptualization of the Gokova karst system

*Sukran Acikel**, Mehmet Ekmekci[1], Deniz Ozbek[1], Levent Tezcan[1], and Turker Kurttas[1]

Department of Hydrology and Water Resources
University of Arizona

The Gokova coastal karst springs are brackish because of the sea water and carbonate rocks which have different hydrogeological properties. This study was undertaken to understand the hydrodynamic structure of the Gokova Karst System (GKS). GKS is located on the over thrust zone of the Bodrum Nappes and the Menderes Massif on the west coast side of Turkey. A wide range of lithological units belonging to either authocthonous or allocthonous rock masses can be observed in the area. About 150 spring outlets along the Azmak-Gokova fault line produce the Azmak stream. The total discharge rate of the springs at the Azmak stream gauge station is about 11m3/sec. Recession curve analyses of daily discharge rates for 3 years were used to understand the hydrodynamic structure of the media. In addition, a borehole's groundwater level was also measured daily in the karst aquifer and its recession curve analyzed. The evaluations of all shows that there are 5 different sub systems in the region. The Recession analyses also indicate that the system works differently for dry and wet period. During wet period, the groundwater comes predominantly from Koprucay and Gokova alluvial systems. In contrast, during dry periods, the Mugla Karst aquifer and Ula karst aquifer are dominant for the groundwater coming to the Azmak system.

*Visiting Postdoctoral Scholar (Zreda Group)

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[1]Hacettepe University

Similarities and differences between transport of a solute and water age mass: Why the picture is so blurry

Ravindra Dwivedi, Thomas Meixner, and Paul A. "Ty" Ferré

Department of Hydrology and Water Resources
University of Arizona

It is tempting to think of water of different ages moving and mixing like solutes. But, there is one fundamental difference. Concentration can remain constant with time (e.g. during steady state transport without decay). But, water age, by definition, changes with time. This leads to unexpected differences between the transport of solutes and the progression of water age mass that can have important implications when using tracers to interpret flowpaths and residence times. I will begin by describing the use of particle tracking or a closed system approach where water flowpaths remain steady and fixed both in space and time. Then I will present methods developed by Ginn (1999) that use the standard Advection Dispersion Equation (ADE). Then, I will explain why treating transport of water age-mass as equivalent to solute transport is theoretically incorrect. Finally, through simple examples, I will demonstrate the errors that can arise when the ADE is used to model water age mass transport. To end on a positive note, I will present a new approach that correctly models water age mass transport.

Determining the source and availability of nutrients to microbes in a coalbed methane system

Marissa Melody Earll, Jennifer McIntosh, and David Vinson[1]

Department of Hydrology and Water Resources
University of Arizona

Coalbed natural gas accounts for about 10% of natural gas production in the USA, 20% of which is microbial in origin (biogenic gas), produced by methanogens in sedimentary basins. Despite the importance of coalbed methane (CBM) as a resource, little is known about the microbial communities responsible for it's generation. It is thought they are limited by nutrients, such as nitrogen or phosphorus and trace metals, and it's hypothesized these nutrients are sourced from in-situ biodegradation of the coal and/or transported in from near-surface environments with groundwater recharge. This study will examine the organic content and nutrient and trace metal geochemistry of the solid coal and associated formation water from CBM wells in the Powder River Basin, MT. Dissolution experiments (chemical extraction of organic and inorganic constituents) core samples will provide insight into what nutrients are present in coalbeds and how they may be mobilized. If significant concentrations of N, P and trace metals are present, in-situ sourcing of nutrients by microbes is highly probable. Water samples from 2 coal seam transects will be analyzed to investigate the biogeochemical evolution of CBM systems across a hydrologic gradient. If microbial-limiting nutrients are transported into coal seams I expect higher concentrations of nutrients in recharge areas compared to deeper coalbeds.

[1]Department of Geography & Earth Sciences, UNC Charlotte

The effect of subsurface soil moisture on gravimeter recordings for aquifer systems in Yavapai County, Arizona

Max Gersh

Department of Hydrology and Water Resources
University of Arizona

Concerns of groundwater storage and supply have been growing in the Prescott Active Management Area (AMA) for a number of years, due to rising populations and the subsequent increase in demand. The aquifer systems in Yavapai County, Arizona have been monitored and studied using an A-10 absolute gravimeter, a relatively new method for measuring relative groundwater storage change, to insure groundwater storage is not being depleted at an uncontrolled rate. One concern is that soil moisture could affect the accuracy of these readings. For this reason, Time Domain Reflectometry (TDR) measurements of soil moisture, at depths of 40cm, 50cm, and 60cm are being collected at 14 different gravimeter sites.

Using historical soil moisture data with the TDR measurements at these depths, we are able to study, and possibly apply, a correctional factor for the gravimeter readings that corresponds with the soil moisture. This factor can be applied to soils with water contents ranging from 5-50 percent to take into account the soil moisture. Initial results of this study show that some sites do not require any noticeable correction, due to the dryness of the soil, whereas some sites would benefit from a correctional value, due to their variability in saturation.

Titan's haze uncertainties and their effects on derived surface albedos

Tymon Khamsi

Department of Hydrology and Water Resources
University of Arizona

Studying the Earth's atmosphere is made difficult by its complex circulation, temperature gradients, and layering. Simpler atmospheric analogues, such as Saturn's moon Titan, make understanding Earth's atmosphere more simple. Titan has a methane cycle that is a rough analogue to Earth's water cycle; its methane budget, however, is not in equilibrium. Methane in the upper atmosphere is efficiently destroyed by incoming solar radiation, creating complex hydrocarbon haze that obscures the planet's surface at most visible and near-infrared wavelengths. Researching the surface then requires an understanding of the absorption and scattering effects of this haze. This work used radiative transfer modeling to investigate light's interaction with optically thick regions in near IR-wavelength bands which do not sense the surface, in order to quantify atmospheric effects on radiation. Increased scattering at longer wavelengths indicates a potential increase in mean particle size with time. Future research will focus on potential mechanisms of particle size change to better model atmospheric scattering and behavior.

Characterizing the hydrologic function of wetlands in Upper Cook Inlet, southcentral Alaska

Colin P. Kikuchi and T.P.A. Ferré

Department of Hydrology and Water Resources
University of Arizona

Wetlands cover nearly half of Alaska's landmass, and provide valuable ecosystem services. In particular, the wetlands of Upper Cook Inlet constitute one of the seven wetlands complexes in the state identified as highly valuable for water and habitat services. The hydrologic function – defined as the collection, storage, and discharge of surface and groundwater – of Alaskan wetlands is highly variable. Many well-studied wetlands in cold regions are underlain by relatively thin mineral soils over bedrock or permafrost. In these kinds of environments, wetland hydrologic function is limited to the exchange of surface water among watershed elements. By contrast, both groundwater discharge and water storage as pore water in peat both contribute to streamflow in wetlands of Upper Cook Inlet. This research uses a coupled groundwater-surface water model to assess the hydrologic function of wetlands in the Goose Creek subwatershed in Upper Cook Inlet. Groundwater boundary conditions are derived from a regional-scale groundwater model of the surrounding glacial aquifer system, and surface-water flow is simulated using a bi-directional, diffusive wave approximation package. Preliminary results are used to identify critical data gaps required to more fully characterize the hydrologic function of wetland ecosystem types.

Impacts on groundwater quality at the Sweetwater Recharge Facility associated with improved effluent source water

Grant Kornrumph, David Quanrud[1], and Dick Thompson[2]

Department of Hydrology and Water Resources
University of Arizona

Secondary effluent water is an untapped resource in many parts of the world. The Sweetwater Recharge Facility, operated by Tucson Water, takes advantage of Tucson's secondary effluent by sending it directly to reclaim customers and by recharging it for storage and further filtration. This allows for potable sources of water to be conserved by reducing the amount of drinking water delivered to over 600 high demand customers, such as golf courses, parks and school fields. This reduces pumping in the Tucson basin, preserving the groundwater, helping to prevent subsidence, and conserving water for future use. Ensuring that this process stays viable and sustainable means monitoring changes to the groundwater using an array of monitor wells. In this study, temporal and spatial trends of nitrogen, total organic carbon, and pH from groundwater samples were examined from 1991 to present to assess impact of 1) improved effluent quality from Class B to Class A and 2) use of newly constructed recharge basins on resultant groundwater quality. The analysis showed that two monitor wells, WR-203A and WR-204A, down gradient of the recharge site, saw a 43 and 197% spike in nitrate, respectively, five months after three new basins became operational. WR-204A also saw a 66% spike in total organic carbon, however both the nitrate and total organic carbon concentrations are returning to previous conditions suggesting the spikes can be attributed to the operation of the three new basins. The pH stayed relatively constant in the wells at an average of 7.2, even though the source water dropped by 0.2 pH. The fact that the groundwater quality appears to be returning to previous conditions suggests the change in source water is having little effect on groundwater quality, ensuring reclaim customers will continue to receive high quality water.

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[1]School of Natural Resources and the Environment, University of Arizona
[2]Tucson Water

Quantifying the response of dissolved organic matter to wildfire

Brianna McClure, Tom Meixner, and John Chorover[1]

Department of Hydrology and Water Resources
University of Arizona

Wildfire frequency and intensity in the Western United States has increased in recent decades and has the potential to alter soil and surface water composition and chemistry. Dissolved organic matter (DOM) is essential to many environmental processes, however it is unclear how DOM responds and recovers to varying severity of wildfire. This study seeks to quantify the impacts of fire on dissolved organic matter by observing the effects of the June 2013 Thompson Ridge wildfire in the Valles Caldera National Preserve in the Jemez Mountains of New Mexico. Data from samples collected in ground and surface waters before and after the fire will be analyzed and characterized by fluorescence index (FI), humification index (HIX), and specific ultraviolet absorbance (SUVA). Comparing pre and post burn values will provide insight to the dynamics of DOM after fire burn. This study may provide an understanding of the duration of impacts and expected rates of recoveries after a fire for important strategic planning and response in terms of water quality and treatment.

[1]Soil, Water and Environmental Science, University of Arizona

A laboratory experiment for detecting the evolution of subsurface heterogeneity and hydrological response

Antonio Alves Meira Neto, Peter A. Troch, and Paul “Ty” Ferré

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University of Arizona

How do plants, energy and water transform the subsurface? What patterns can be extracted from this interaction and how do they affect water partitioning and redistribution? The Mini-LEO is a sloping metallic lysimeter, constructed as a small-scale version of Landscape Evolution Observatory artificial hillslopes. The initially pristine soil inside the Mini-LEO will be observed for 2 years, where it will experience a climatic forcing and growth of herbaceous plants. Weathering of the soil and development of the rooting system will cause this system to evolve over time. We expect to monitor the development of heterogeneity by assessing the local hydraulic conductivity distribution through sequential Electrical Resistivity Tomography (ERT) surveys and in situ monitoring of soil characteristics. We will also track the evolution of the systems response, by monitoring the chemical composition of water at the seepage face and inside the soil during the systematic application of tracer-labeled rainfall events. This project will try to observe patterns linking the development of heterogeneity and hydrological change and how to detect them at larger scales such as at the LEO hillslopes.

Response of infiltration rate to improvements in effluent quality at the Sweetwater Recharge Facility

Laura Nakolan, Thomas Meixner, and Dick Thompson[1]

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University of Arizona

Reclaimed water systems allows drinking water to be conserved by reducing the amount of potable water applied to large water-use sites like golf courses and parks. Advancements in effluent infiltration can amplify this conservation by making more reclaimed water available through increased storage of water in groundwater reservoirs. This study assesses the practicality of water quality improvement as a method of enhancing effluent infiltration. This examines the infiltration rate changes in the 11 recharge basins at the Sweetwater Recharge Facility and the Santa Cruz River following an improvement in source water quality. Whereas Roger Road Wastewater Treatment historically provided class B treated effluent to the Sweetwater Recharge Facility, it now provides class A water due to the removal of nearly 100 percent of nitrates and 50 percent of phosphates. Initial findings show an overall improvement in basin and river infiltration rates after the water quality shift, indicating that water quality improvement is in fact a valid method of improving recharge.

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[1]City of Tucson-Tucson Water

Evaluation of the normalized seasonal wetness index (NSWI) for seasonalizing estimates of groundwater recharge in arid and semiarid western U.S. basins from climatic data

Kirstin L. Neff, Hoori Ajami[1], and Thomas Meixner

Department of Hydrology and Water Resources
University of Arizona

In the arid and semi-arid Basin and Range Province of the Western U.S., groundwater recharge is the sole natural input of water to aquifers on which large populations often depend for their water supply. Measuring groundwater recharge directly presents a challenge due to the difficulty of instrumentation and the spatial and temporal heterogeneity of recharge processes in Basin and Range systems. The Basin and Range experiences a primarily bimodal precipitation regime, with dry summers and wet winters often characterized by snow accumulation on mountaintops. In the southern Basin and Range, the North American Monsoon also has influence. Stable water isotopic data for basins throughout the region indicate that winter precipitation contributes disproportionately more to annual recharge than summer precipitation. The Normalized Seasonal Wetness Index (NSWI) has been proposed as a method to estimate seasonal recharge volumes for use in hydrologic models that reflect the impact of regional climatology on annual recharge. The NSWI has previously been shown to closely estimate the percent of annual recharge occurring in the summer and winter seasons for the Upper San Pedro Basin in southeastern Arizona, as determined from stable water isotope analysis. This paper applies the NSWI method for seasonalizing recharge to a suite of other basins in the Basin and Range for which similar isotopic studies have been conducted and can be used to validate the NSWI results. Seasonalization of recharge using the NSWI shows great promise for incorporating global climate model data into hydrologic models that seek to predict aquifer conditions under future climate scenarios.

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[1]University of New South Wales School of Civil and Environmental Engineering

Using LSMs to estimate recharge in the western U.S.

Rewai Niraula, Thomas Meixner, Matthew Rodell[1],
David Gochis[2], Hoori Ajami[3], and Christopher Castro[4]

Department of Hydrology and Water Resources
University of Arizona

Groundwater is a major source of water in the western U.S. However, there are limited recharge estimates in this region due to the complexity of recharge processes and limited observations. Land surface Models (LSMs) could be a valuable tool for estimating current recharge and projecting changes due to future climate change. In this study, simulations of three LSMs (Noah, Mosaic and VIC) obtained from North American Land Data Assimilation System (NLDAS-2) are used for assessing recharge estimates across the western US. Modeled recharges are compared with published recharge estimates for 10 aquifers in the region. Mosaic is consistent in underestimating recharge significantly across all the basins. VIC seems to overestimate in the dry aquifers while underestimate in the wetter ones. Noah overestimated recharge in the drier basins but capture reasonably well in the wetter basins. Although rates varied, the models were consistent in identifying high and low recharge areas in the region. Models tend to agree in seasonality of recharge occurring dominantly during the spring across the region. Our results highlight that LSMs have the potential to capture the spatial and temporal patterns of recharge at large scales; however, more observational studies are required for improved parameterization.

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[1]Hydrolological Science Branch, NASA GSFC
[2]NCAR HR Regional Modelling
[3]University of New South Wales School of Civil and Environmental Engineering
[4]Atmospheric Sciences, University of Arizona

Using noble gases to determine residence time of water in carbon-reservoirs: A test case in the Powder River basin, Montana

Daniel Ritter, Jennifer McIntosh, and Tom Darrah[1]

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University of Arizona

Determining the residence time of water in organic rich sedimentary basins is a key component of understanding the interaction between hydrogeology, geochemistry, and microbial processes. The amount of time water has been in an aquifer can affect how much water-rock-microbial interaction can occur, and is also an important variable in understanding how groundwater pumping might affect water resources. 3H and 14C are common residence time tracers used in sedimentary basins, but in older, carbon-rich basins these tools may not be able to provide residence times, since water is often too old (>~50 years) to use 3H, and 14C added from organic matter in the basin may dilute atmospheric contributions of 14C to below detection.
Noble gas samples were collected from 16 wells across the Tongue River Watershed in the Powder River Basin, a Tertiary coal basin located in Wyoming and Montana. Seven samples were collected from monitoring wells along transects in 2 coal seams, 4 samples were collected from a set of nested monitoring wells, and 5 samples were collected from production wells. He, U, and Th concentrations of coal were also measured to determine the amount of in-situ 4He production. 4He ages range from ~200 to ~170,000 years. He concentrations in coal were much higher than expected given the 4He concentrations in the water, suggesting that water sampled was likely in contact with other formations, besides the coal, for most of its history. These insights into residence time will help to further understanding of timing and rates of water-rock-microbial interactions, as well as give insight into residence time of fluids in western coal basins.

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[1]School of Earth Sciences, Ohio State University

Water use by semiarid shrubs: An experimental two-layer perspective

Matthew Rotunno, Shirley Papuga, and Steven Archer

School of Natural Resources and the Environment
University of Arizona

In semiarid ecosystems, precipitation pulses reaching deep soil layers have been shown to drive plant transpiration (T) dynamics. However, hydraulic redistribution complicates the relationship between precipitation-driven moisture pulses and plant-water use. We hypothesize that roots of semiarid shrubs will translocate moisture from shallow to deeper soil layers to enhance productivity. To test this hypothesis we will experimentally manipulate the water content of shallow and deep soil layers in planters containing Larrea tridentata shrubs in a greenhouse setting and quantify plant water use. Surface soils will be sealed to prevent evaporation and porous hydrophobic membranes will be used to create four contrasting soil moisture scenarios: (1) a dry shallow and a dry deep layer; (2) a wet shallow and a dry deep layer; (3) a wet shallow and a wet deep layer; and (4) a dry shallow and a wet deep layer. A mixing model based on stable water isotopes will be used to determine: (1) the soil layer(s) being used for shrub T; (2) if shrubs transfer soil moisture between layers and (3) how these interactions differ between scenarios. Ultimately, this will help us clarify and simplify the transpiration component of evapotranspiration dynamics in models of land-surface atmosphere exchange.

Near-real-time streamflow monitoring and forecasting along with the estimation of uncertainties in a multi-model multi-product platform

Tirthankur Roy, Aleix Serrat-Capdevila, Juan B. Valdes, Hoshin V. Gupta, Eleonora M. Demaria, and Matej Durcik

Department of Hydrology and Water Resources
University of Arizona

Forecasting of streamflow is challenging because of the complex non-linear nature of various rainfall-runoff transformation mechanisms. Lack of ground observations, poor temporal and spatial coverage of available data, frequently occurring prolonged missing records, instrument errors in data collection, delayed data retrieval, etc. exacerbate the situation and make it even a bigger challenge to monitor and forecast streamflow, particularly in the developing countries with limited resources and inadequate infrastructure. Furthermore, lack of knowledge about natural systems inevitably induces uncertainties in their mathematical models. These uncertainties need to be dealt with efficiently in order to develop a reliable framework. This presentation talks about the experimental near-real-time streamflow forecasting and monitoring platform prototype for African basins developed by the SERVIR Water Africa-Arizona Team (SWAAT) in The University of Arizona. Different scientific and engineering issues related to the development of the prototype and the future plans are also discussed during the course of this presentation.

Spatial and temporal influence of Redondo Peak headwaters in the East Fork Jemez river using a principal component analysis approach

R. Andres Sanchez-Romero and Thomas Meixner

Department of Hydrology and Water Resources
University of Arizona

The Valles Caldera is a volcanic collapse feature located in the Jemez Mountains in northern New Mexico, southwestern United States. This region is characterized by a bimodal precipitation pattern, i.e. spring snowmelt and summer monsoon rains. Redondo Peak is located in the center of the Valles Caldera, it has several springs that drain around all sides of the peak with different hydrologic responses. The main catchments (headwaters) identified in Redondo Peak are: La Jara, Upper Jaramillo, History Grove and Upper Redondo. The main questions that are going to be answered in this research are: Do these head waters affect the chemistry in East Fork Jemez river? and if so, how does this influence varies in space and time? A Principal Component Analysis (PCA) approach is used to address these questions. Analyzed water samples for water isotopes and major anions and cations are the inputs for the analysis. These samples come from the flumes located at each catchment in Redondo Peak, and at two different locations along the East Fork Jemez. Preliminary results among the head-waters in Redondo show that La Jara, Upper Jaramillo and History Grove have similar chemical composition suggesting that these three catchment share one or several end members, whereas Upper Redondo space is more scatter therefore is more than likely speak of different source of water. The proposed methodology is going to be applied using data from the East Fork Jemez river in different locations to evaluate what is going to be the influence of the these headwaters in each locations.

Using stable water isotopes in a two-layer soil moisture conceptual framework to understand transpiration dynamics in a semi-arid shrubland

Daphne J. Szutu and Shirley A. Papuga

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University of Arizona

Semiarid shrublands and other dryland ecosystems are highly responsive to precipitation pulses. Climate models project long-term changes in the frequency and magnitude of precipitation events in dryland systems, which in turn will have an effect on moisture distribution in the soil profile. Previous research suggests that transpiration dynamics in drylands are associated with deep soil moisture, which accumulates after large precipitation events. A hypothetical decrease in large precipitation events would decrease deep soil moisture, which could reduce water available for transpiration and biomass accumulation, with major consequences for the health and functioning of dryland ecosystems. The effect of long-term precipitation changes in pulse-dependent dryland ecosystems is still unclear because the relative contribution of transpiration to evapotranspiration (T/ET) and the temporal dynamics of this contribution are not well understood. The objective of this research is to better characterize the temporal dynamics of transpiration in dryland ecosystems. We present eddy covariance, soil moisture, and sap flow measurements taken over 18 months at a creosote bush-dominated shrubland ecosystem at Santa Rita Experimental Range in southern Arizona. Additionally, we analyze soil moisture and stable water isotopes within the context of a two-layer soil moisture conceptual framework. We found that the soil moisture depth that plants use for transpiration is seasonal, i.e., transpiration is correlated with deep soil moisture and evaporation was correlated with shallow soil moisture in the summer. Further, we show that the source water for deep soil moisture varies with the timing and duration of the storm. We expect our study will contribute to understanding where precipitation pulses are distributed in the soil moisture profile and when these pulses are used for transpiration in dryland ecosystems. Ultimately these findings should improve the representation of drylands within global water and carbon budget models.

Sources of recharge to groundwater in Davidson Canyon, southeast Arizona: An isotopic tracer study

Rachel S. Tucci and Jennifer McIntosh

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University of Arizona

Davidson Canyon is the largest channel that drains the proposed controversial Rosemont Copper Mine, and a tributary to Cienega Creek. Lower Davidson Canyon is classified as Outstanding Arizona Waters (OAWs). Questions have been raised about the potential impacts of future mining activities on surface water and groundwater resources in the area. Background studies of hydrogeochemical conditions are needed in order to evaluate, any future sources of contamination, were it to occur. This preliminary study utilizes natural isotopic tracers (18O, 2H, 3H) to investigate the source of recharge, relative ages of groundwater at different locations, and groundwater-surface water interactions in the Davidson Canyon watershed. Water samples were collected from 18 domestic wells and 5 surface water sites; additional data from 33 surface water sites and precipitation collectors were obtained from Hudbay Minerals Inc. and PAG. In contrast to other isotopic studies of nearby basins, initial results show no relationship between δ18O and δD values and seasonality of precipitation. The precipitation collectors were located at similar elevations, thus it wasn't possible to determine if there is a trend of δ18O and δD values with elevation. Longer-term and more spatially distributed records of precipitation in the study area are likely needed. Most of the groundwater and springs have δ18O and δD values that plot between Tucson Basin winter and summer precipitation average values, which suggest a mixing of recharge source waters. Tritium levels in groundwater and spring samples were zero to 2.2 TU, indicating water was recharged prior to 1952.

Identifying basin scale heterogeneity of soil properties using river stage tomography

Yu-Li Wang, YuanYuan Zha, Tian-Chyi Jim Yeh, and Jet-Chau Wen[1,2]

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University of Arizona

Observations and simulation of soil heterogeneity were carried out to understand the characteristics of the soil properties in the alluvial fan of Chuoshui river, Taiwan. The fan is located at middle Taiwan with an area of 1800 km^2 and has at least one unconfined and three confined aquifers. All aquifers are connected to each other at apex of the fan.
The distribution of soil hydraulic conductivity was estimated by fusing naturally recurrent stimuli and groundwater head. Specifically, the covariance and correlation information provided by temporal and spatial change of groundwater head in response to river stage variations are used to estimate heterogeneity of hydraulic conductivity. The results of the estimate compared with other geo-investigate method are discussed.

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Co-evolution of volcanic rock dominated catchments

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Present landscapes have co-evolved over time through various interactions of prevailing climate and geological conditions. Understanding the linkage between spatial patterns of landscape and hydrological response offers a valuable framework to explain the variability of hydrological systems. Catchment co-evolution is a concept that seeks to formulate hypotheses about the mechanisms and conditions that determine their historical development of catchments. In this study, we selected 14 volcanic rock dominant catchments that have different ages, ranging from 0.22 to 82Ma. In these catchments, we derived indices including landscape features (e.g. drainage density and slope area relationship) and hydrological responses (e.g. baseflow index, annual water balance and slope of flow duration curve). As a result, we revealed that the age of volcanic rock have significant connection to intra-annual or seasonal water balance. Younger catchments tend to have larger component of groundwater flow, while older ones exhibit more flashy hydrographs. The decrease in baseflow suggests that the major flow pathways have changed from deep groundwater aquifers to shallow subsurface flows. We also revealed that the drainage densities of the catchments have decreased with catchment aging. Although drainage density is controlled by an aridity index to some extent, catchment age have a more significant impact on the changes in drainage density. One explanation for this observation is that in early stages of volcanic catchments, most of the infiltrated water flows vertically due to high permeability of the basalt. As time progresses, subsurface impermeable layer develops due to chemical weathering, and major flow pathway changes to shallow subsurface flow rather than vertical flow. This change would result in shorter transit time of water and flashy hydrological responses. As chemical weathering continues, recharge to deep aquifer decreases, and further disconnection of the channel network from aquifers would result in decrease in drainage density. We argue this is one of the empirical evidence of catchment co-evolution that will rigorously be tested by future works.

*Visiting Postdoctoral Scholar (Troch Group, Biosphere 2)

Joint Round Table Session with the Departments of Atmospheric Sciences & Hydrology and Water Resources

Thursday, April 9 at 1:00PM
Rincon Room, Student Union Memorial Center

A joint round table session with the Department of Atmospheric Sciences and the Department of Hydrology and Water Resources will be moderated by Dr. Hoshin Gupta (HWRS) and Dr. Francina Dominguez (ATMO).

Students will explore our common ground by asking the question, *In what ways do the problems of "water provision" and "natural hazards" require a broader interdisciplinary perspective,* through discussion of the changing nature of extremes and water sustainability in the western U.S.

Please join us for an informal and stimulating discussion!

NOTES

NOTES

Save the date!

2016 El Día del Agua
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March 30, 2016

in conjunction with

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EarthWeek 2015

EarthWeek is a joint conference organized each spring by students in the School of Earth and Environmental Sciences (SEES) and the School of Natural Resources and Environment (SNRE) which features research symposia with students from:

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Department of Atmospheric Sciences

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Department of Hydrology & Water Resources

GeoDaze
Department of Geosciences

LTRR Talks & Tours Day
Laboratory of Tree Ring Research

SNRE Poster Day
School of Natural Resources and the Environment

SWESx
Department of Soil, Water, & Environmental Sciences

Information Online at:
http://www.hwr.arizona.edu/el-día-2015
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Front Cover Image:
Sweetwater Wetlands, Tucson, Arizona
Photo: T. Thompson

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