THE UNIVERSITY OF ARIZONA

Department of Hydrology and Water Resources

Welcomes you to the

24th Annual El Día del Agua

USDA-ARS Variable Intensity Rainfall Simulator at the ARS Walnut Gulch Experimental Watershed

April 9, 2014
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 24th 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 (HWR), a department known worldwide for its cutting-edge research in hydrology and related sciences. This year we are pleased to host a full-day event with student oral presentations, student research posters, and two invited guest speakers.

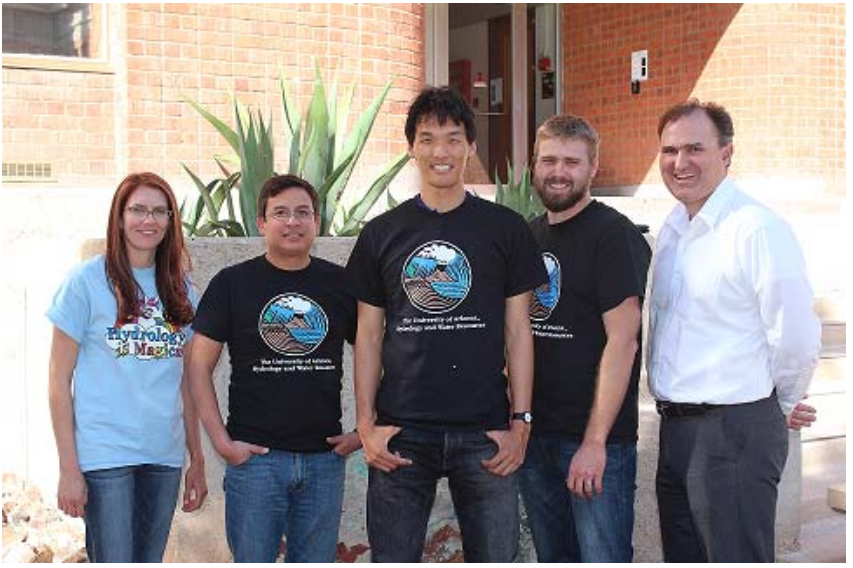
As a public forum, the event enables students to meet and network with alumni, faculty members from across campus, and other working professionals from the water community which strengthens the ties among these groups. The event also promotes career and professional development through informal meetings and presentations by visiting alumni and other potential employers to students interested in water-related careers.

El Día also provides a great opportunity for prospective students to learn more about the wide range of research opportunities available to HWR 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 HWR faculty, students, and staff members, as well as the UA's 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



(Above) From Left to Right: Kirstin Neff, Social Chair; Xavier Zapata-Rios, Vice President; Michael Tso, Treasurer; Derek Groenendyk, President; and Dr. Thomas Meixner, Faculty Advisor. Not Shown: Daniel Trail and Marlyn Ripalda, Undergraduate Representatives

El Día del Agua
Morning Schedule

8:00-8:55 **Register/Check-in and Breakfast** (North Ballroom)

8:55-9:00 **Welcome** Dr. Larry Winter, Professor and Department Head, Hydrology and Water Resources, and Derek Groenendyk, President, Hydrology and Water Resources Student Association for 2013-2014

9:00-10:00 **Oral Presentations** Moderator, **Dan Ritter**

9:00-9:20 Xavier Zapata-Rios, The role of aspect and water flow paths on silicate mineral weathering in a semiarid mountainous region

9:20-9:40 Adam Karczynski, Measuring unsaturated hydraulic conductivity at the sub-kilometer scale using cosmic-ray neutrons

9:40-10:00 Derek Groenendyk, A k-means clustering approach to assess wheat yield prediction uncertainty with a HYDRUS 1D coupled crop model

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

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

11:00-11:20 Diana Zamora-Reyes, Flood heterogeneity as a tool for exploring flood frequency-climate linkage

11:20-11:40 Michael Tso, Hydrologic tomography: Let the data tell the story

11:34-12:00 Tongchao Nan, Scaling and extreme value analysis of hydrogeological variables with application to neutron porosity data in oilfields

El Día del Agua
Afternoon Schedule

12:00-1:30 **Buffet Luncheon & Luncheon Speaker** (South Ballroom)
Dr. Thomas Meixner, Professor & Associate Department Head, HWR, and El Día del Agua Chair: Introduction to Luncheon Speaker, **Hale W. Barter**, Montgomery and Associates, Inc. and HWR Alumnus, *Groundwater's integral role in mining*.

1:30 - 2:30 **Oral Presentations** Moderator, **Colin Kikuchi**

1:30-1:50 Rodrigo Valdes, Analysis of long-term changes in annual and seasonal precipitation in Chile and related large-scale atmospheric circulation patterns

1**:50-2:10 Kirstin Neff**, Seasonality of groundwater recharge in the basin and range province, Western North America

2:10-2:30 Dan Ritter, Relationship between recharge, redox conditions and microbial methane generation in coalbeds

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

3:30-4:30 **Keynote Speaker** (North Ballroom)
Dr. Larry Winter, Professor and Department Head, HWR, and El Día del Agua Co-Chair: Introduction to Keynote Speaker, **Kathleen Dominique**, Organization for Economic Co-operation and Development, *Water security in a changing climate: Managing risks and trade-offs.*

4:30-5:15 **Presentation of Awards and Prizes**
Montgomery Prize by Errol Montgomery
Hargis Awards by Damian Gosch
HWR Awards by Larry Winter
Donald R. Davis Award by Thomas Meixner
Eugene S. Simpson Award by Thomas Meixner
Aqua-Person Award by Derek Groenendyk

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

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Faculty Advisor | Dr. Thomas Meixner

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Moderators | Dan Ritter (AM), Colin Kikuchi (PM)
Microphones | Adam Karczynski, Jacob Prietto
Photographer | Kirstin Neff
Poster Boards & Supplies | Rey Reyes
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Organizing Committee

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IT & Technical | James Broermann
Logistics & Research Support | Tim Corley
Website & El Día Program | Terrie Thompson

Department Advisory Council
2013-2014 Members

The Department Advisory Council (DAC) was organized in 1991 and is comprised on HWR alumni and 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*
Daniel B. Stephens & Associates, Albuquerque, New Mexico

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David R. Hargis
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Hargis + Associates, Tucson, Arizona

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Peter Mock Groundwater Consulting, Inc.
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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: Clare Stielstra, Luke Pangle, Martha Whitaker

Hargis Awards

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

HWR Awards of Excellence

Best Oral Presentation (excluding Montgomery Prize winner)
Best Poster (excluding Hargis Award winners)
Certificate and Award of $400 for each award
Judges: (Oral) Kim Beisner, Greg Leonard, Jim Washburne; (Poster) Tim Corley, James Callegary, Bob Sejkora

Donald R. Davis Undergraduate Distinction Award

Outstanding Undergraduate Award (Academic or Research)
Certificate and Award of $400
Judges: Derek Groenendyk, Kirstin Neff, and Xavier Zapata-Rios

Eugene S. Simpson Undergraduate Poster Award

Best Undergraduate Poster in Hydrogeology, Subsurface Hydrology, or Groundwater
Certificate and Award of $400
Judges: Derek Groenendyk, Kirstin Neff, and Xavier Zapata-Rios

The Montgomery Prize

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

LEGACY SPONSOR

for their support of the 24th 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 HWR 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:

- Groundwater exploration and development
- Contaminant assessment and remediation
- Artificial groundwater recharge
- Assured and Adequate Water Supply demonstrations
- Hydrologic monitoring
- Satellite image analysis
- Groundwater flow and solute transport modeling

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 24th 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. HWR Alumnus Dr. Leo Leonhart, Principal Hydrogeologist and Chief Technical Director, Hargis+Associates, Inc., in Tucson, annually presents 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.

Hargis+Associates, Inc., established in 1979 by HWR 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:

Industrial
Aerospace
Mining
Water resources
Government and legal

As a client service organization, Hargis+Associates, Inc. takes pride in being attentive and efficient in meeting their client's needs and solving their problems. In addition to technical expertise, communication and responsive coordination are hallmarks of their reputation.

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.

Even though the halcyon days of funded research were behind him, until shortly before his death, he 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, Dr. Davis 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.

Dr. Donald R. Davis 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

Hale W. Barter
Hydrologist, Principal
Montgomery & Associates, Inc.

Hale W. Barter began consulting in 1988 and joined Montgomery & Associates (M&A) in 1994. He received his B.S. and M.S. degrees in hydrology from the University of Arizona. His focus in groundwater modeling has led to extensive involvement in diverse mining hydrology projects for clients throughout the Americas. These projects have ranged from water supply and mine dewatering investigations to environmental impact assessments and investigations supporting regulatory compliance.

Mr. Barter leads the large modeling group at M&A, and currently serves as the firm's chief financial officer and as a member of the board of directors. M&A is a water-resource consulting firm that employs approximately 100 staff in its Tucson, Phoenix, Denver, Santiago, and Lima offices.

Groundwater's integral role in mining

Groundwater is integral to most aspects of mining, from water supply and mine dewatering to post-closure water quality monitoring and contaminant remediation.

The mining industry's dependence on water—coupled with its potential to impact water resources—presents hydrologists with an extensive range of important roles to fill. The science is typically complex, the settings are often heterogeneous and uncertain, stakeholders can have competing agendas, and investigations sometimes unfold under challenging economic or political conditions.

If you are a hydrologist practicing in the Southwest U.S., you'll probably find yourself working on a mining project at some point in your career. Although the mining industry can be cyclical, for most of the last decade it has been a major source of revenue and growth to groundwater consulting companies like M&A despite otherwise depressed economic conditions.

Mr. Barter will discuss the typical progression of a mining project, from pre-feasibility studies to planned closure, including the regulatory overlay that informs nearly all aspects of mining hydrology.

He will address the challenges associated with developing defensible solutions with limited time and data in very complex settings. To illustrate these concepts, he will present a few examples in both North and South America where M&A has provided groundwater expertise.

El Día Del Agua
Keynote Speaker

Kathleen Dominique
Environmental Economist
Organization for Economic Cooperation and Development

Kathleen Dominique is an Environmental Economist at the Organization for Economic Co-operation and Development (OECD), where she leads OECD's work on water resources allocation and water and climate change adaptation. She also undertakes economic and policy analysis on other key water issues, including water security and country specific policy dialogues on water. Prior to joining OECD, Kathleen researched barriers to the innovation and diffusion of low carbon energy technologies at the Paris-based think tank the Institute of Sustainable Development and International Relations. She has also spent several years working with the banking and financial services sectors as a consultant at PricewaterhouseCoopers in San Francisco, CA as well as several years teaching English in Port Harcourt, Nigeria. Kathleen has a Master's in Public Affairs from Sciences Po in Paris and a Bachelor's in Business Administration from the University of Notre Dame in the US.

Water security in a changing climate: managing risks and trade-offs

A world economy four times larger in 2050, and with over 2 billion additional people, will need more water. The OECD Outlook projects global water demand to increase by some 55%, intensifying competition for freshwater by industry, energy production, households, irrigation and ecosystems. Water quality will continue to be a challenge.

Despite some progress on expanding access to water supply, by 2050, an estimated 240 million people are still expected to lack access to water supply and an estimated 1.4 billion people are expected to be without access to sanitation.

Water-related disasters continue to make headlines around the world—from the record drought in California to the recent floods in the UK. At the same time, climate change is bringing new challenges and greater uncertainty about future conditions for freshwater.

Responding to these water security challenges requires well-targeted investments, good water governance, and new thinking to inform and motivate policy action.

The OECD has developed a novel risk-based approach to water security in a changing climate. It aims to support government efforts to better understand the water risks we face, set appropriate policy targets, and manage them with the full suite of policy options available.

Oral Presentation Abstracts

The role of aspect and water flow paths on silicate mineral weathering in a semiarid mountainous region

Xavier Zapata-Rios, Jennifer McIntosh, and Thomas Meixner

Department of Hydrology and Water Resources
University of Arizona

Silicate weathering is a fundamental process that controls carbon sequestration, buffers acidification, supplies nutrients to ecosystems, and influences chemical composition of natural waters. Recent studies show that water residence time plays an important role in the weathering of silicates minerals. In semi-arid regions terrain aspect influences energy and water fluxes that in turn affect soil development, water transit time and water flow paths. In this study, we test how terrain aspect influences silicate weathering along diverse draining slopes of Redondo Peak, a semi-arid mountain in northern New Mexico dominated by rhyolite rocks with a silicate mineral composition (sanidine, anorthoclase, oligoclase and quartz). This investigation uses an aqueous phase methodology examining major and minor solute concentrations in water given that they are derived predominantly as a product of water-rock interactions. Solute concentrations from water draining Redondo were contrasted to landscape characteristics that were defined using an airborne LIDAR flight coverage. In addition water chemistry was integrated using the geochemical models MINTEQA2 and Netpath to investigate main silicate weathering reactions along different flow paths. Initial results show significant correlations between mineral weathering products and landscape characteristics. Contributing area to springs correlates with Na ($R2=0.71$; $p<0.0001$) and DIC concentrations ($R2=0.59$; $p<0.0006$). The correlation between Na and DIC versus aspect is $R2=0.71$ ($p<0.0001$) and $R2=0.59$ ($p<0.0006$), respectively. Similarly, ^{3}H measured at the springs and aspect are significantly correlated $R2=0.52$ ($p<0.01$).

Measuring unsaturated hydraulic conductivity at the sub-kilometer scale using cosmic-ray neutrons

Adam M. Karczynski and Marek Zreda

Department of Hydrology and Water Resources
University of Arizona

Unsaturated hydraulic conductivity is normally measured in the laboratory on small samples extracted from the field. To obtain area-representative properties, numerous point samples must be measured, which is expensive and time consuming, and then the results averaged. The ability to measure area-average unsaturated hydraulic conductivity at the field scale would be an important advance. The objective of this research is to derive unsaturated hydraulic conductivity using a cosmic-ray (or COSMOS) soil moisture probe. The COSMOS probe provides average soil moisture for a circular area of approximately 600m in diameter to a depth up to 0.5m by measuring neutron intensity in the air above the soil surface; this intensity is inversely correlated with soil moisture. Field-scale unsaturated hydraulic conductivity was calculated from changes in neutron-derived soil moisture at the Manitou Forest site in central Colorado. Laboratory-scale properties were measured on 36 soil samples, collected within the COSMOS footprint, by the evaporation technique as implemented in the UMS HYPROP device. Unsaturated hydraulic conductivity parameters for each sample were determined by fitting the van Genuchten – Mualem model to the measured changes in pressure and mass of each sample. The neutron intensity based parameters were found to be consistent with those measured experimentally, suggesting that COSMOS data may be used to estimate effective unsaturated hydraulic conductivity over the sub-kilometer COSMOS footprint.

A k-means clustering approach to assess wheat yield prediction uncertainty with a HYDRUS-1D coupled crop model

Derek Groenendyk, Kelly Thorp[1], and T.P.A. Ferré

Department of Hydrology and Water Resources
University of Arizona

Soil moisture, especially under drought conditions, is a factor that is known to impact crop yield predictions. Crop growth models used to make these predictions rely on soil texture estimates, which influence simulated soil moisture and ultimately crop growth. The purpose of this research was to implement a k-means clustering approach to address the uncertainty of the soil texture estimates. By grouping together similar soil textures based on their simulated responses, clustering reveals how soil texture uncertainty may impact yield estimates. Wheat growth simulations were conducted using a HYDRUS 1D and coupled crop model for soils defined on the USDA soil texture triangle. A k-means clustering algorithm was applied to the simulated soil moisture time series data for each soil texture. Resulting clusters were different from traditional soil type classifications and in some cases were similar to wheat yield prediction response. The k-means clustering approach is useful for investigating uncertainty in factors that affect crop yield simulations. The impacts of soil texture uncertainty on soil moisture behavior as well as other factors should be considered when conducting crop growth simulations.

[1]USDA-Agricultural Research Service, Maricopa, AZ

Flood heterogeneity as a tool for exploring flood frequency-climate linkage

Diana Zamora-Reyes and Katherine Hirschboeck[1]

Department of Hydrology and Water Resources
University of Arizona

Accurate discharge estimates are needed to reduce flood damage. In the US, these estimates are calculated following Bulletin 17b. Although two assumptions made are flood homogeneity and no climatic variability, further exploration is encouraged. Arizona has three flood-producing mechanisms: summer and tropical cyclone convective thunderstorms, and winter synoptic-scale storms. In an earlier study, regional patterns of flood heterogeneity appeared to influence discharge estimates. This study builds on these results by exploring the temporal and spatial relationship between heterogeneity and climatic variability. USGS partial duration series were classified by meteorological cause. Subsequently, records were analyzed using Change-Point Analysis for breaks in the mean of Frequency, or number of floods, and Magnitude, or size of largest flood, for each classification per water year. The records reveal a decrease/increase in number and size of convective/winter-synoptic floods across the State/Central Arizona consistent with a shift to drier summers/wetter winters, as determined from other studies. These results show spatial and temporal variability in magnitude and frequency in Arizona. By classifying floods and studying their variability in magnitude and frequency we can find a way to simulate future climate. This work is needed in Arizona because recent studies suggest a considerable increase in future flood damage.

[1]Laboratory of Tree-Ring Research, University of Arizona

Hydrologic tomography: Let the data tell the story

Michael Tso, Yuanyuan Zha[1], and Tian-Chyi Jim Yeh

Department of Hydrology and Water Resources
University of Arizona

Hydraulic tomography (HT) is a groundbreaking approach for groundwater aquifer characterization (Yeh and Liu 2000). It involves collecting responses throughout an aquifer due to a sequence of overlapping aquifer tests and then calibrating a heterogeneous groundwater flow model using the observed responses from all the tests. Multiple sets of aquifer tests and their observed responses improve the groundwater inverse problem because they cross validate each other. As a result, the estimated hydraulic property fields become more detailed and less uncertain than those computed from a single set of data (i.e. traditional pumping test analysis). Here we discuss some of the lessons learned from the recent sequential aquifer tests that took place in the Mizunami Site in Japan and North Campus Research Site (NCRS) in Waterloo, Canada [Berg and Illman 2011, 2013]. We present also a new stochastic inverse estimator that incorporates both formation flux and head responses at observation locations to invert aquifer parameters. We test the estimator against two synthetic domains, one representing a fracture system and the other a multimodal heterogeneous system with strong layering. The results suggest that the addition of flux responses to HT analysis better predicts fracture connectivity and solute transport.

[1]Visiting Research Scholar, HWR; Doctoral Student, Wuhan University, China

Scaling and extreme value analysis of hydrogeological variables with application to neutron porosity data in oilfields

Tongchao Nan, Shlomo P. Neuman, Alberto Guadagnini[1], Monica Riva[1], and C. Larrabee Winter

Department of Hydrology and Water Resources
University of Arizona

Many earth, environmental and other quantities possess heavy-tailed distributions that sometimes decay with separation scale (lag) and exhibit long-range correlations. Corresponding sample structure functions of order q display power-law scaling in a midrange of lags with breakdown in power-law behavior at small and large lags. The power-law exponent may vary in a nonlinear fashion with q. Whereas the literature has traditionally attributed this nonlinearity to multifractals, we know today that it could also be associated with samples from sub-Gaussian random fields or processes subordinated to fractional Brownian motion (fBm) and/or fractional Gaussian noise (fGn), which are artificially truncated during sampling. Such fields constitute mixtures of truncated fBm or truncated fGn with random variances. Here we explore the statistical scaling behaviors of extreme values associated with such samples. We do so by considering peaks over threshold (POT) in synthetic as well as real data; our synthetic data represent sub-Gaussian fields subordinated, effectively, to fBm on finite domains via two different schemes. We find that POT do exhibit distinct statistical scaling in synthetic data generated by both subordination schemes. Similar behavior is exhibited by neutron porosity data from six deep boreholes in oilfields. Our results are potentially applicable to a wide range of hydrological as well as other spatial and temporal variables.

[1]Dipartimento di Ingegneria Idraulica, Ambientale, Infrastrutture Viarie e Rilevamento, Politecnico di Milano, Italy

Analysis of long-term changes in annual and seasonal precipitation in Chile and related large-scale atmospheric circulation patterns

Rodrigo Valdes-Pineda, Juan B. Valdés, Henry F. Díaz[1], and Aleix Serrat

Department of Hydrology and Water Resources
University of Arizona

The main features of interannual and intraseasonal precipitation variability along Chile are analyzed by using a new compound dataset of more than 200 ground stations with different lengths of records between 1866 and 2013. An exhaustive quality data control was applied with the objective to obtain a reliable dataset for further analysis. Cluster analysis was used to determine homogeneous climatic regions. Then Principal Component (PC) analysis was applied over Standardized Precipitation Index (SPI) values at annual and seasonal scales, in order to obtain the percentage of explained variance of precipitation and its relation to different circulation anomalies indexes: Southern Oscillation Index (SOI), Multivariate Enso Index (MEI), Pacific Decadal Oscillation (PDO), and Antarctic Oscillation (AAO), among others. Finally the spatial and temporal precipitation patterns are analyzed for stations with longer records, with the aim to detect possible trends and its relation with significant circulation anomalies indexes obtained from previous PC results.

[1]Climate Diagnostics Center, NOAA, Boulder, CO

Seasonality of groundwater recharge in the basin and range province, Western North America

Kirstin Neff, Thomas Meixner, and Lissette de la Cruz

Department of Hydrology and Water Resources
University of Arizona

Groundwater recharge is the primary source of replenishment to aquifers, an important source of freshwater for human consumption and riparian habitat sustainability in semi-arid regions. It is critical to understand the current recharge regimes in basins throughout the Western U.S. and how they might shift in the face of climate change, land use change, and management manipulations that impact the availability of groundwater resources. Watersheds in the Basin and Range Province are characterized by a bimodal precipitation regime of wet summers and wet winters. The horst-graben structure of these basins engenders orographic and continental precipitation effects that make mountain system recharge critical components of annual recharge. The current assumption is that the relative contributions to recharge by summer and winter precipitation vary throughout the province, with winter precipitation dominating in the northern parts of the region, and summer monsoonal precipitation playing a more significant role in the south, where the North American Monsoon extends its influence. Indeed, the Spring Mountains (southern NV) exhibit about 80% winter recharge, the Upper San Pedro Basin (southern AZ) about 65% winter recharge, and preliminary data from the Rio San Miguel (Sonora, MX) suggest about 60% winter recharge. To test this hypothesis, stable water isotope data of groundwater and precipitation from sites in Sonora, Mexico and the U.S. states of California, Nevada, Utah, Arizona, Colorado, New Mexico, and Texas are examined to characterize and compare groundwater recharge regimes throughout the region.

Relationship between recharge, redox conditions and microbial methane generation in coalbeds

Daniel Ritter, Jennifer McIntosh, and David Vinson[1]

Department of Hydrology and Water Resources
University of Arizona

Coalbed methane (CBM) represents a significant portion of the world's natural gas reserves, and approximately 20% of the world's natural gas is thought to be microbial in origin. Laboratory and field experiments have shown that microbes are actively generating CBM in many sedimentary basins worldwide. In order to better understand in situ conditions which lead to microbial CBM generation, samples were collected in areas of sulfate reduction and methanogenesis in the Powder River Basin. Results from the Powder River Basin were also compared with results from other studies in the Williston Basin, Elk Valley Coalfield, Manville Coalfield, and the Illinois Basin to investigate what impact groundwater flow and recharge might have on methanogenesis. It was expected that there would be different pathways and conditions for methanogenesis in different areas of the basins (i.e. basin margins versus basin centers). Coal waters associated with methanogenesis have relatively consistent major ion chemistry, with $SO4^{2-}$ concentrations < 0.1 mM. The relationship between $\delta^{13}C$ of CO2 and CH4 varies by sample location in the basins, and to a lesser extent between basins. These variations could indicate a lower extent of methanogenesis at basin margins and higher extent of methanogenesis at basin centers relative to non-methanogenic processes such as sulfate reduction. Organic carbon analysis showed greater biodegradation in sulfate reducing coals than in methanogenic coals. Microbiology results showed that samples collected from sulfate reducing areas in different basins were more similar to each other than to samples collected from methanogenic areas in the same basin.

[1]Northwestern University, Chicago, IL

Poster Presentation Abstracts

A water budget for the lower Colorado river multi-species conservation program at the Palo Verde ecological Reserve: A riparian habitat

Arien Chavez and Matt Grabau[1]

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The Lower Colorado River provides water for many communities across the desert southwest, including indigenous and migratory fauna, some of which are listed under the Endangered Species Act. Recovery of native habitat along this stretch of river is essential to their survival. The Palo Verde Ecological Reserve is one of several sites created under the Habitat Conservation Plan for the Multi-Species Conservation Program, implemented by the Bureau of Reclamation. The Reserve, which is approximately 5 miles north of Blythe, California, comprises nine management plots, or phases, each of which is irrigated to support restoration strategies aimed at providing riparian habitat. Identifying the behavior and effectiveness of applied irrigation requires extensive surveying and monitoring. To this end, a 78 acre plot was monitored using soil, water, and weather instruments from May 2012-July 2013. Data collected during this period allow for analysis of irrigation effectiveness and calculation of a water budget. This paper quantifies irrigation behavior by accounting for water loss due to percolation below the root zone, evapotranspiration, and plant water consumption. By identifying these data, and considering the goals of the program, a water budget may provide support in planning future similar projects and also in modeling long-term water needs.

[1]GeoSystems Analysis, Tucson, Arizona

Particulate transport of organic nutrients in disturbed forest catchments

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North American forests have experienced increasing tree mortality over the last two decades due to drought and insect infestations with unclear impacts on water quantity and quality. Snowmelt dominated streams from these forests are one of the primary sources of water for the Western US. Because the removal of organic matter from municipal supplies is both costly and results in dangerous bi-products, our study focused on quantifying the dynamics of Dissolved Organic Matter (DOM) and Particulate Organic Matter (POM) in response to extensive Mountain Pine Beetle-induced tree mortality in Wyoming. Both Dissolved Organic Carbon (23.5 ±4.7 mg C/L) and Dissolved Organic Nitrogen (0.57 ±0.24 mg N/L) concentrations were higher than reported values for streams draining unimpacted forests. In contrast, Particulate Organic Carbon (0.87 ±0.55 mg/L) and Particulate Organic Nitrogen (0.09 ±0.05 mg N/L) were lower than typical values for unimpacted catchments. POM concentrations exhibited hysteresis with larger concentrations transported on the rising limb of the snowmelt peak compared to subsequent, comparable flows suggesting a flush of source material. This pattern was not apparent for DOM. In 2011 the mean C:N for DOM was 38.0 (±2.0) and the mean C:N POM was 10.0 (±0.6) suggesting that the POM originated from in-stream material while the DOM was terrestrially sourced. Continuing analysis will compare this site with a healthy site in order to fully assess the impact of drought and insect mortality on headwater catchment basins.

[1]USDA-Agricultural Research Service, Southwest Watershed Research Center, Tucson, Arizona

Sources of water and solutes to the aquifer geologic structural controls near the Ismailia and El Kassara Canals of North Eastern Egypt.

Muhammad Gomaah[1] and Thomas Meixner

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The aquifers of the region surrounding the Ismailia and el Kassara canals in northern Egypt have significant salinity issues. The potential sources of water to these aquifers include old recharge from the Nile, newer irrigation flows after the closure of the High Aswan Dam, local precipitation and water from an underlying Miocene aquifer system. Solute concentrations (and thus salinity) of the aquifers include these sources as well as evaporative concentration, dissolution of calcite and dolomite as well as silicate weathering of the underlying aquifer material. The key challenge in this system is differentiating among these sources of water and solutes. Using water isotopes, solute concentrations and sulfate isotopes we sought to answer two questions about this system. First, what is the relative importance of the four potential water sources to the underlying aquifer system? Second, what role does each of the potential salinity sources play in determining the total dissolved solids in the aquifer? The results for the system indicate a minimal influence of the underlying Miocene aquifer as a water and solute source which is a different result than for the next aquifer south, Miocene aquifer. Similarly local precipitation plays a minimal role while old and new Nile river water represent the main sources of recharge. The role of Old Nile water is significant as it indicates the aquifer has relatively long water residence times. Calcite dissolution and evapoconcentration are the key solute sources with a subsidiary role for continued silicate weathering of the aquifer.

[1]Visiting Research Scholar, HWR; Doctoral Student, Desert Research Center, Egypt

Sediment concentration in the Chagres river, Panama

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University of Arizona

The Panama Canal is one of the most important waterways in the world and the largest economic source of income for Panama. In 2010 the Chagres River, the major contributor to the Panama Canal Watershed (PCW), was inundated by tropical storm "La Purisima" which lasted three days, impacting the economy and the environment. About 644 mm of rainfall were measured at the Chico Station in the Chagres River during the 3-day storm and caused a large increase in the sediment load in the PCW. This caused temporary closure of the ship transit through the Canal and in the water supply service for Panama and Colon cities. The sediment contribution of the Chagres River during the storm was 1,813,186 tons, which was 70% of 2010 total sediment contribution (2,582,681 tons). This project compared the sediment load and discharge of La Purisima with 2011-2012 data. The results help to predict the sediment load of similar storm events in the future. These values were also compared to the historic average values to understand changes in precipitation and discharge in recent years in the PCW to improve management of sediment concentration to avoid future closures in the ship transit.

[1]Meteorology and Hydrographic Branch, Engineering Division, Panama Canal Authority, Panama

A k-means clustering approach to assess wheat yield prediction uncertainty with a HYDRUS-1D coupled crop model

Derek Groenendyk, Kelly Thorp[1], and T.P.A. Ferré

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Soil moisture, especially under drought conditions, is a factor that is known to impact crop yield predictions. Crop growth models used to make these predictions rely on soil texture estimates, which influence simulated soil moisture and ultimately crop growth. The purpose of this research was to implement a k-means clustering approach to address the uncertainty of the soil texture estimates. By grouping together similar soil textures based on their simulated responses, clustering reveals how soil texture uncertainty may impact yield estimates. Wheat growth simulations were conducted using a HYDRUS 1D and coupled crop model for soils defined on the USDA soil texture triangle. A k-means clustering algorithm was applied to the simulated soil moisture time series data for each soil texture. Resulting clusters were different from traditional soil type classifications and in some cases were similar to wheat yield prediction response. The k-means clustering approach is useful for investigating uncertainty in factors that affect crop yield simulations. The impacts of soil texture uncertainty on soil moisture behavior as well as other factors should be considered when conducting crop growth simulations.

[1]USDA-Agricultural Research Service, Maricopa, AZ

Constructing paleoclimate proxies through soil δD values at Hall's Cave, Texas

Jordan Jimmie and Timothy Shanahan[1]

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Reconstructing past climate changes is crucial for understanding how the climate system will improve in the future. Such studies are crucially important in the southwestern US, where recent droughts have resulted in severe hydrological and ecological stresses. In Texas, there exist few high-resolution, continuous paleoclimate records that would provide an understanding of longer-term climate variability in this region. To address these issues, we develop a new record of past climate change in central Texas from the sediments of Hall's Cave. Changes in the carbon isotope composition of bulk sediment are interpreted as reflecting the relative abundances of winter plants using the C3 photosynthetic pathway, and C4 summer grasses. The carbon isotope record from Hall's Cave suggests that conditions were much drier during the glacial, became wetter for a brief period of time during the deglaciation (i.e., 15-13 ka) and then became dry again in the early Holocene. Only over the past 5-6 ka did conditions begin to permanently shift towards conditions more similar to today. These changes likely reflect significant reorganizations of atmospheric circulation associated with changes in the Pacific westerly and Gulf of Mexico moisture sources. Ongoing and future work will focus on reconstructing changes in the hydrogen isotope composition of terrestrial leaf wax-derived compounds (long chain n-alkanes), which will provide a record of changes in the relative importance of these moisture sources in association with past wet and dry intervals.

[1]University of Texas at Austin, Jackson School of Geoscience

Groundwater recharge in the Lagunillas basin, Chile

Colin Kikuchi and T.P.A. Ferré

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Closed basins in the Atacama Desert, Chile are rare and sensitive hydrologic environments. The Lagunillas basin is one such basin which supports a perennial lagoon, and has also been the focus of historical and ongoing groundwater development activities. To guide sustainable groundwater-surface water management, a study has been undertaken to characterize long-term rates of natural groundwater recharge in the Lagunillas basin. The first part of the study uses an existing calibrated groundwater model of the basin to quantify uncertainty surrounding basin-scale estimates of groundwater recharge using null space Monte Carlo techniques. The second part of the study includes continuous monitoring of subsurface temperatures in boreholes and both perennial and ephemeral streambeds. Borehole temperature profiles are analyzed to estimate diffuse, in-place groundwater recharge, and streambed thermographs are used to estimate both background and event-based infiltration rates. Preliminary results show model-predicted and measured groundwater recharge rates to be roughly consistent. Future efforts will use field data collected during this study to refine, and ultimately reduce uncertainty on basin-scale recharge estimates.

Water quality changes at Southern Avra Valley Storage and Recovery Project (SAVSARP) shows higher than expected concentrations of total hardness as a result of cation exchange, mineral dissolution and precipitation

Alyssa Miller, Dick L. Thompson[1], and Thomas Meixner

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Groundwater quality is affected by artificial recharge of Colorado River water from the Central Arizona Project (CAP). Recovered CAP water currently influences approximately 80% of potable water delivered to Tucson Water customers. SAVSARP began recharging CAP water in April 2008. Water quality samples collected from 2008-2013 show trends of recovered well water transforming from $HCO3^-$ into $SO4^{2-}$ dominant compositions, suggesting mixing of CAP water with groundwater. Stable isotope analysis shows that the most proximal wells are now 100% CAP water. Such wells have increased in concentration by approximately 120% in TDS, 1800% in $SO4^{2-}$ and 120% in total hardness. Mixing model analysis shows higher than expected concentrations of Ca and total hardness as well as lower than expected concentrations of Mg, Na, K and $HCO3^-$, suggesting possible geochemical changes beyond just mixing. Ion exchange, dissolution and precipitation of species are likely responsible. Spikes in concentrations of NO3-N and Br are observed prior to when the CAP water composition became dominant. The spikes are attributed to a flushing of constituents from the vadose zone in the initial surge of CAP water. Eventually, recovered well water is expected to stabilize at approximate CAP source water composition, but subsurface interactions may alter composition towards higher salinity and hardness than pure CAP water.

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[1]City of Tucson-Tucson Water, Tucson, Arizona

Estimating recharge in western U.S.: Effect of LSM choice

Rewati Niraula and Thomas Meixner

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Arid and semi-arid aquifer systems of the Western U.S., where groundwater is a major water resource, depend on variable recharge processes influenced by local climatology, ecology, geography, soils, and geology. There are limited recharge estimates due to the challenges of studying recharge processes. Approaches for estimating recharge are important for responding to challenges from projected population, land use and climate changes. Several Land Surface Models (LSMs) have been developed that represent land surface and atmospheric process. These LSMs are aimed at improving the estimates of various water, energy and carbon fluxes. LSMs vary in complexity for the treatment of exchange of energy, mass, momentum and CO2 between land surface and overlying atmosphere. Here we used three LSMs (i.e. NOAH, MOSAIC and VIC) for modeling the recharge across western U.S. The modeled recharges were then compared with the recharge estimates from the literature for several aquifers in the region. NOAH and MOSAIC captured the regional pattern in recharge but did not represent annual average recharge well. The models were consistent in identifying high and low recharge areas. In general, estimates from NOAH were consistently higher compared to those from MOSAIC except for very high recharge zones. Over the western U.S. the recharge ranged between 0 to 3228 mm/year with an average annual value of 40 mm based on MOSAIC. The recharge ranged between 1 to 1260 mm/year with an average annual recharge of 63 mm based on NOAH. In terms of current recharge estimates, neither of the models proved to be better over the other; neither did particularly well. In a few cases the modeled recharges were comparable (i.e. same order of magnitude) to the recharge estimates. Many basins had recharge values that differed considerably between the models' estimates and literature values.

Identifying ancient glacial features in the Circum-Argyre region, Mars, using HiRISE, CTX, and MOC imagery

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Today, Mars is cold and dry, but the geomorphic features across its surface suggest an ancient geological history of fluvial and glacial modification. In the Argyre Basin and the mountainous region that surrounds it, features such as eskers, U-shaped valleys, moraines, streamlined-landforms, and bouldery till deposits have been identified from orbiting satellite imagery (Kargel and Strom 1992, Banks et al. 2008, 2009, Hiesinger and Head 2002). Together, these features are indicative of glaciation, and perhaps wet-based glaciation. In this study, HiRise, CTX and MOC imagery were used to identify land surface features in the Charitum Mountains to the South and West of Agyre that are consistent with the glacial modification hypothesis. Features identified include moraine candidates, terrestrial-scale esker candidates, hummocky terrain, streamlined landforms, and lineated grooves. Glacially modified topography has implications for the Martian global climate history. In particular, wet-based glaciation would imply paleoatmospheric conditions conducive to sustained liquid water on Mars.

Effluent infiltration: the effects of discharge and water quality in the lower Santa Cruz river

Jacob Prietto and Larry Winter

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From 2005 to 2012, the Tucson metropolitan region generated an average of 68,000 acre-feet of wastewater per year. 78% of the wastewater (effluent) was discharged to the Lower Santa Cruz River, where streambed infiltration accrues recharge credits for stakeholders of the managed underground storage facilities. Recharge is calculated by stakeholders from the daily effluent discharge from Roger Road WRF and Ina Road WRF, the USGS mean daily discharge at Cortaro Road and Trico Road stream gauges, and evapotranspiration constants. Streambed infiltration in an effluent dominated river is driven by the development of a clogging layer. "Schmutzdecke," the black anaerobic layer immediately below the soil surface, is created through physical, chemical and biological processes working in combination to reduce the soil permeability. Large storm flows scour away the clogging layer and is a significant factor contributing to infiltration. Without the occurrence of large storm flow events, other parameters have a potential effect on the infiltration of effluent, during non-storm flow conditions. Daily discharge, Ammonia, Biochemical Oxygen Demand, and Total Suspended Solids are evaluated during the spring and fall dry seasons to determine correlation with infiltration. To avoid the influence of large storm flows in the study area, time series began an average of 37 days after the last major event (+1000 AF/day) of the prior rainy season. The WRFs have since received upgrades to accommodate the growth needs through 2030 and meet new limits on effluent water quality concentrations. The study is an evaluation of infiltration during the pre-upgrade conditions.

Multi-model and multi-product streamflow forecasting in the African basins

Tirthankar Roy, Aleix Serrat-Capdevila, Juan B. Valdes, Matej Durcik, Hoshin V. Gupta, and Rajarshi Mukherjee

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Streamflow forecasting plays a crucial role in effective water management. However, there are various challenges involved in developing such a tool for operational use. Problems persist at various stages of model development starting from the availability of data in the near-real-time to the accuracy and precision of the final forecasts. Precipitation is one of the prime forcings for the streamflow forecasting models, and satellite precipitation products (SPPs) are the only available sources of precipitation data in the near-real-time from various parts of the world. SPP estimates, however, show discrepancies while compared with each other, the reason of which is attributable to various sensor technologies and data assimilation algorithms. The SPPs also show significant bias while compared to the ground observations. This study relied on multi-product and multi-model approach to deal with different issues related to individual SPP and hydrological model for developing a reliable forecasting platform. Three different SPPs, such as, PERSIANN-CCS, CMORPH, and CHIRPS are used in the study along with two hydrological models, such as, HyMod (lumped) and VIC (distributed) to develop a forecasting platform in the Mara River basin of Africa. CHIRPS is used to correct the bias in other two SPPs as it assimilates the ground observations and is believed to be the most reliable among the other contemporaries. Various comparative studies are carried out to assess the level of performance of different products and models. Some of the important findings are presented.

Visions in the desert: An exploratory study on the Santa Cruz river, its health and what we should (or shouldn't) do about it

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This exploratory study delved into the spectrum of potential perceptions Tucsonans have about the health of the Santa Cruz River, along with attempting to explain why such perceptions are formed, and how they affect opinions of river management. Many fields and formats of data, including verbatim transcripts, short and long interviews and short surveys, were collected in order to group responses into certain stances. Demographic and experiential responses were then analyzed according to those stances, in order to postulate potential explanations of those perceptions and their effects on river management opinions. While there were not enough data from the transcripts to categorize the perceptions of those involved in the same manner as the interviews and surveys, two general stances emerged from those responses that were categorized; a basic and a nuanced stance on river health. Many responses did not fall into either of these two stances, indicating that spectrum of perceptions does exist. While respondents with a basic stance had no experiential patterns to explain why they aligned with that stance, those with a nuanced stance all had intimate experience with the river along with at least an undergraduate level academic background. There were no discernable patterns in opinions towards river management.

The automated geospatial watershed assessment tool (AGWA): Developing post-fire model parameters using precipitation and runoff records from gauged watersheds

B.S. Sheppard, E. Canfield[1], S. Burns[2], G. Sidman[2], D.P. Guertin[2], D. Goodrich[3]

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New tools have been incorporated into the Automated Geospatial Watershed Assessment Tool (AGWA) to assess the impacts of wildfire on runoff and erosion. AGWA is a GIS interface jointly developed by the USDA-Agricultural Research Service, the U.S. Environmental Protection Agency, the University of Arizona, and the University of Wyoming to automate the parameterization and execution of a suite of hydrologic and erosion models. AGWA delineates and discretizes the watershed using a Digital Elevation Model (DEM). Watershed model elements are then intersected with terrain, soils, and land cover data layers to derive model input parameters. With the addition of a burn severity map AGWA can be used to model post wildfire changes to a catchment. By applying the same design storm to burned and unburned conditions a rapid assessment of the watershed can be made and areas that are the most prone to flooding can be identified.

Post-fire precipitation and runoff records from gauged forested watersheds are now being used to make improvements to post-fire model input parameters. Rainfall and runoff pairs have been selected from these records in order to calibrate parameter values for surface roughness and saturated hydraulic conductivity used in the KINEROS2 model. Currently Department of Interior Burn Area Emergency Response (DOI BAER) teams are using the AGWA-KINEROS2 modeling interface to assess hydrologically imposed risk immediately following wild fire. These parameter refinements are being made to further improve the quality of these assessments.

[1] Pima County Flood Control District, Tucson, Arizona
[2] University of Arizona, School of Natural Resources and the Environment
[3] USDA-Agricultural Research Service, Southwest Watershed Research Center, Tucson, Arizona

The analysis of infiltration rates within recharge basins by tilling and varying water depth

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For successful water resource management in the arid southwestern U.S. artificial aquifer recharge using reclaimed water is becoming a more viable option. Maximizing infiltration rates is an important goal for reducing costs and time as well as increasing the amount of useable and available reclaimed water. Analysis of data from Tucson Water's Sweetwater Recharge Facility from July 1, 2013 – January 20, 2014 showed that infiltration rates vary inconsistently when the water depth within particular basins is changed. When analyzing the eight specific basins (RB-1 – RB-8), the majority showed relatively constant infiltration rates even after varying the water depth. However, RB-1, RB-3, RB-4, and RB-8 showed increased rates when filled to approximately 2-3 feet versus filling to approximately one foot cycles. This could be due to increased spreading area as lateral seepage into the basin's sloped walls increased with water depth as well as pressure head. In addition, one basin, RB-4, was drained and tilled on December 19th. The average rate in RB-4 in October was 0.20 ft/day and in November was 0.068 ft/day. In December the rate increased to 0.77 ft/day and in January increased even more to 0.95 ft/day. RB-4 saw an average increased rate of 0.66 ft/day based on data from October 1st, 2013- January 20th, 2014. Close attention to rates versus cycles, filling depth, and bottom conditions is critical to maintain long term hydraulic loading rates.

[1]City of Tucson-Tucson Water, Tucson, Arizona

The virtue of flux measurements during hydraulic tomographic surveys in highly layered aquifer systems

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Hydraulic Tomography (HT) is a reliable aquifer characterization method available that stochastically incorporates observations at different locations from different pumping tests to provide a best, unbiased estimate of the hydraulic parameter fields of an aquifer model. Recently, Zha et al. (2014) pioneered the use of flux measurements to condition HT estimates. Here we implement their method to estimate the 3D hydraulic conductivity (K) field of a highly heterogeneous 5-layered synthetic system using a domain that mimics the Waterloo North Campus Research Site (NCRS) site in Ontario, Canada. Advective velocity controls the transport of solute in groundwater systems. Common approaches, however, only consider their agreement to head and/or hard data when assigning parameter fields to numerical models. Since flux field governs advective velocity, we argue that an HT algorithm that incorporates both head and flux measurements for conditioning would provide significantly better K estimate and solute transport predictions. Using steady-state HT, we show that the addition of flux measurements not only improves the pattern of K estimate, the K estimate using both head and flux data is able to reproduce solute transport observations in great agreement to that simulated using the true or reference K field. This indicates that the use of HT with flux conditioning may be a promising approach for solute or contaminant transport modeling.

[1]Visiting Research Scholar, HWR; Doctoral Student, Wuhan University, China
[2]Vice President, GSI Environmental Inc.; Technical University of Munich, Germany; University of Waterloo, Canada

Streamflow generation through precipitation – induced subsurface flow: A controlled experiment to examine the capillary fringe hypothesis

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In order to successfully experiment on the full-scale Landscape Evolution Observatory (LEO) slopes in Biosphere 2, a mini LEO slope has been constructed to mimic the larger-scale experiments. In hydrology, the streamflow generation mechanism states that when the zone of tension saturation extends to, or near the ground surface, the application of a small amount of water can cause an immediate rise in the water table, and the magnitude of the rise is much greater than would be expected with normal specific yield values for sandy materials. However, subsequent modeling studies have illustrated that the formation of a capillary fringe may actually cause saturated conditions at the soil surface, leading to rapid surface runoff of precipitation. To compare with the previous studies, a permeable seepage face and novel weighing lysimeter devices have been installed on the mini LEO slope. Unique tracers that had each rain pulse at variable precipitation rates and under specific initial soil-water storage conditions have also been applied. These will allow us to numerically evaluate the capillary fringe hypothesis and investigate groundwater-surface water interactions during the process of streamflow generation in order to obtain a new understanding of the capillary fringe hypothesis. Ultimately, we would utilize the same method on three large-scale LEO slopes and predict hydrologic processes during landscape changes in Earth system behavior.

Quantifying the effects of wildfire on the volume and chemical composition of interception

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University of Arizona

Wildfires are more frequent in the western United States now than ever before and have the potential to combust plant biomass, volatize nutrients, alter soil composition and affect surface water chemistry. Throughfall and stemflow capture and divert precipitation as it falls through a forested landscape; however, it is unclear how the chemistry of precipitation and interception will change after fire. This study seeks to quantify the effects of fire on volume and chemical composition of interception by observing the effects of the June 2013 Thompson Ridge wildfire in the Valles Caldera National Preserve in the Jemez Mountains of New Mexico. Throughfall and stemflow collectors will be installed beneath both burned and unburned canopies in three catchments impacted by the Thompson Ridge fire. The volume of precipitation intercepted by burned and unburned canopy will be measured and compared. Throughfall, stemflow and precipitation samples from forested and open areas will also be analyzed for trace metals, major cations, anions, nutrients and organic matter. This will be one of the first studies to quantify the relationship between wildfire and the chemistry and flux of interception in conjunction with a full suite of pre and post fire precipitation, soil and surface water chemistry.

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

Detecting fracture connectivity in a nuclear waste deposit site using hydraulic tomography

Yuanyuan Zha[1] and Tian-Chyi Jim Yeh

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University of Arizona

Four large-scale cross-hole pumping tests were conducted at the Mizunami Underground Research Laboratory (MIU) construction site in central Japan. During these tests, induced groundwater responses were monitored at many observation intervals at various depths in different boreholes at the site. We analyze the data using steady-state and transient hydraulic tomography (THT). Results show several, distinct, high and low conductivity zones that are continuous over hundreds of meters, which appear to delineate fault zones and their connectivity. These results corroborate well with observed water level records and available fault information. A further synthetic simulation using both drawdown and flux data show that observation of flow rate can greatly improve the estimation of fracture connectivity. The successful application of hydraulic tomography to cross-hole pumping tests conducted at this site suggests that hydraulic tomography is a promising approach to delineate large-scale hydraulic parameter heterogeneities and fracture connectivity.

[1]Visiting Research Scholar, HWR; Doctoral Student, Wuhan University, China

Notes

Save the date!

2015 El Día del Agua
Wednesday
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EarthWeek 2014

EarthWeek 2014 is a joint conference organized each spring by students in the School of Earth and Environmental Sciences (SEES) which features research symposia with students from:

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Front Cover Image:
Demonstration of the USDA-ARS Variable Intensity Rainfall Simulator over a 2 x 6 plot at the semi-arid ARS Walnut Gulch Experimental Watershed on March 6, 2014. Photo: T. Thompson.

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