Unsaturated Zone

UZ IG

Interest Group

The semi-annual Unsaturated Zone Interest Group (UZIG) newsletter highlights current topics concerning the unsaturated zone. Its purpose is to enhance communication within UZIG. It is not an official publication and should not be cited. Please contact authors or members of the newsletter committee with any questions, comments, and/or suggestions. Send desired changes in the mailing list to jtrost@usgs.gov.

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Banner photo (top): Tufa mound north of a 44,000-acre playa in northern Dixie Valley, north-central Nevada. P*hoto by Amanda Garcia, U.S. Geological Survey.*

LETTER FROM THE CHAIR

During the preparation of the previous issue of the UZIG newsletter, I was eagerly anticipating the UZIG meeting at the University of Florida in Gainesville. Now, looking back after a series of good presentations and a beautiful field trip, I'm very thankful for all who contributed to make that meeting a success. I was intrigued by both the diversity of unsaturated zone research and the similarities in the kinds of questions scientists are being challenged to answer. Dr. Upmanu Lall started the meeting with a big data, national look at scales of climate variability and implications for the hydrologic cycle, vegetation dynamics, and human settlement patterns. A diverse series of technical presentations followed that examined unsaturated zone processes at pore, field, and regional scales in areas from the humid southeast to the desert southwest.

Nitrate transport was one topic that came up in a few presentations and in several of my conversations. In Florida, for example, some of the students I met were examining the transport of nitrate and other contaminants through extremely sandy soils where corn was being grown. I talked with a USGS scientist from Delaware, who was also studying nitrate transport through sandy soils on the Delmarva Peninsula. In Minnesota, my home state, nitrate is a widespread groundwater and surface-water quality issue. In all of these circumstances, local governments and agencies are interested in solving the nitrate issue because of the human and environmental health risks associated with it. In Des Moines, Iowa, the municipal Water Works brought a lawsuit against rural drainage districts because they

were releasing high amounts of nitrates into the Raccoon River, which is the city's water supply. The suit was dismissed, but still highlights society's interest in solving the nitrate issue. This year, NOAA announced that the dead zone in the Gulf of Mexico was the largest one ever measured, covering 8,776 square miles. Nitrate doesn't get the full blame, phosphorus is also an important nutrient responsible for water quality impairments.

The agricultural nitrate issue is an interesting intersection of economics, soil and plant biology, and hydrology. The "leaking" of nitrate into the environment is at its core an unsaturated zone problem, but there are larger factors that are driving what is planted on the landscape. Everyone desires food, clean water, and a means to make a living, so how can we maintain a viable rural economy, maintain productivity, and minimize the loss of nitrate? It is an age-old question that has been studied for decades, but has not been satisfactorily resolved yet. As unsaturated zone scientists, we have a technical working knowledge of how nitrate and water move through the environment, but is that taken into consideration as a producer decides what to plant? Why or why not? How accessible do you make that information to the producers managing the landscape? How can you better communicate your research and understanding of the unsaturated zone so that successful reductions in nitrate can be accomplished?

I used nitrate as an example, but there are many water impairments resulting from how the unsaturated zone is managed. I encourage everyone in their scientific endeavors to think about how to make your knowledge accessible to the people who require information to make sound decisions. Communication is key.

Respectfully,

Jared Trost

2017 UZIG Meeting

Land-Use Change, Climate Change, and Hydrologic Extremes: Unsaturated Zone Responses and Feedbacks

UZIG members from around the world gathered in Gainesville, Florida for the 2017 UZIG workshop. This year's program included a keynote address from Dr. Upmanu Lall, almost 2 days of oral and poster presentations, a short course on episodic recharge as well as an all-day field trip examining unsaturated zone science in North Florida forests and a visit to one of Florida's Outstanding waters, Ichetucknee Springs, where participants experienced a unique world-renowned aquifer system.

Our keynote speaker was Dr. Upmanu Lall, Alan & Carol Silberstein Professor of Engineering & Director of Columbia Water Center, Columbia University. His talk titled "From Paleo to Future climates: How could interannual to decadal to secular climate variations interact with vegetation, humans, soils and determine the phase space of the unsaturated zone" set the tone for the meeting and generated conversations throughout the week. We thank Upmanu and his wife, Joy, for being engaged participants in our meeting. Also, we would like to thank the University of Florida Water Institute for sponsoring refreshments for the keynote address and travel expenses for our keynote speaker.

Keynote speaker Upmanu Lall presenting in the welcome session.

UZIG Presentations

Workshop presentation topics were diverse, including multiphase CO_2 attenuation in shallow aquifers; nitrate, pathogen and radionuclide transport; preferential flow; episodic recharge; forest management; modeling critical zone water storage; and understanding how climate signals propagate through the unsaturated zone. One member, Ofer Dahan, travelled all the way from Israel to present his real time vadose zone sensor deployment technology. The breadth and depth of the presentations at this years' workshop illustrates the diversity of unsaturated zone science. For more information visit our meeting webpage https://mn.water.usgs.gov/uzig/meetings.htm

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UZIG Field Trip

The field trip began with a tour of a field experiment that seeks to quantify effects of forest management on unsaturated zone fluxes and ended with a kayak survey of a pristine spring ecosystem, Ichetucknee Springs.

The field trip was led by UZIG members David Kaplan, Subodh Acharya, and Wesley Henson. At the forest eddy covariance tower site, UZIG members got a change to see unsaturated zone science in Florida—a place not known for its unsaturated zone. The focus of this project is to understand how unsaturated flows change based on forest management such as understory development and burn frequency.

Austin Carey Forest Research Site. Ofer Dahan, Marco Pazmino, Mike Plampin, John Nimmo, Alex Soroka, Jared Trost, Enrique Orozco López, Jesse Dickenson, Christophe Darnault, Wes Henson, Kim Perkins, Upmanu Lall, David Kaplan, Maria Zamora, Beth Lall, Elin Jacobs, Bernardo Cardenas, Subodh Acharya, Nick Teague (From left to right, back to front).

UZIG Field Trip (continued)

The second half of the field trip focused on one of Florida's Outstanding Waters, Ichetucknee River. The Ichetucknee river is a completely spring fed river, comprised of flow from a group of 6 major springs and hundreds of unmapped seeps. This unique ecosystem is typical of North Florida, and unique to this part of the world. This area has the highest density of first magnitude springs in the world. UZIG members observed Blue Heron, turtles, Great Egrets, and alligators while paddling through crystal clear water under a canopy of river cypress.

Ichetucknee Head Spring. Marco Pazmino, Enrique Orozco López Jared Trost, Mike Plampin, Alex Soroka, Jesse Dickenson, Maria Zamora, Nick Teague.

Ichetucknee River Turtles basking in the sun.

Florida Gator at Austin Carey Research Forest

Great Egret hunting for fish.

2017 UZIG Short Course

UZIG members John Nimmo and Kim Perkins offered a short course called "**Quantifying Episodic Aquifer Recharge: Relation to Total Recharge, Storm Characteristics, and Climate Change".** This course presented fundamentals of episodic recharge and demonstrated the Episodic Master Recession (EMR) method for quantification using time series data of water level and precipitation. This method has been recently published (DOI 10.1111/gwat.12177) and the software can be obtained by contacting Kim Perkins (kperkins@usgs.gov).

UZIG Meeting Sponsors

The UZIG Meeting Planning Committee would like to extend special thanks to our sponsors for this event. The Water Institute provided support for our keynote speaker. IFAS research provided conference materials. The Department of Agricultural and Biological Engineering provided facilities. The Engineering School of Sustainable Infrastructure & Environment provided transportation. Dr. Munoz-Carpena's Biocomplexity research group provided event support. Dr. David Kaplan and his research group made our field trip possible. The USGS provided meeting organization and support staff.

The resources, facilities, and support they provided enabled us bring in a world class keynote speaker, enhanced our meeting program, and allowed us to keep costs reasonable so that it was affordable and accessible to students, post doctoral researchers and visiting scholars from all over the world. Thank you for making our 7th Unsaturated Zone Interest Group Workshop one to remember.

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UZIG Vision Session and Vadose Zone Journal Special Section

The last session of our workshop focused on our vision for unsaturated zone research. Key points that were discussed was where data gaps still exist, the future of unsaturated zone research, the plethora of new data sources coming online, and how we can start to standardize measurements across measurement methods. These discussions and meeting research have led to a special section in the Vadose Zone Journal, UZIG Research: Land-Use and Climate Change Impacts on Vadose Zone Processes. This special section will explore a range of topics including long-term, climate-driven infiltration cycles, disturbed soil processes, large data set processing, novel vadose zone modeling approaches, and innovative field techniques and equipment. Each of these topics represents an important aspect of measuring, conceptualizing, and understanding the myriad influences that climate and land-use change have on the vadose zone. An important sub-theme to this special section is data. Environmental sensing technologies coupled with open-source coding are producing an abundance of high-resolution data that provide in situ information for understanding climatic influences on the unsaturated zone.

We invite submission of papers from UZIG members and other interested scientists. We invite papers that seek to understand vadose zone processes in climate-driven landscape disturbances such as wildfire and in engineered landscape disturbances such as agricultural production. We invite papers that demonstrate advances in modeling or measuring flow and transport in the vadose zone. Finally, we invite papers that present approaches for deploying sensors in the vadose zone and for processing large, continuous data sets that give insight to vadose zone interactions with climate and land-use change.

If you would like to contribute to the special section the deadline for submission of papers: Feb. 1st 2018. https://dl.sciencesocieties.org/files/publications/vzj/uzig.pdf

UZIG Webinars

The UZIG webinar series provides real-time presentations of cutting-edge unsaturated zone science to UZIG members and anyone who accesses it through the web. The webinar series provides an easily-accessible forum for UZIG members to introduce themselves and share their research results. Especially important in this time of restricted conference attendance, the series provides a way to maintain personal connections with other scientists, and keep up with current research. Past and future webinar information is on the webinar series web page: http://mn.water.usgs.gov/uzig/webinars.htm.

September 13th Buck Sisson presented "Estimating Aquifer Recharge Using Soil Water Monitoring Data". Soil water percolating below the depth of roots is an important variable in aquifer recharge studies, estimating the quantity of water moving through buried waste, quantifying irrigation return flow, or deter-

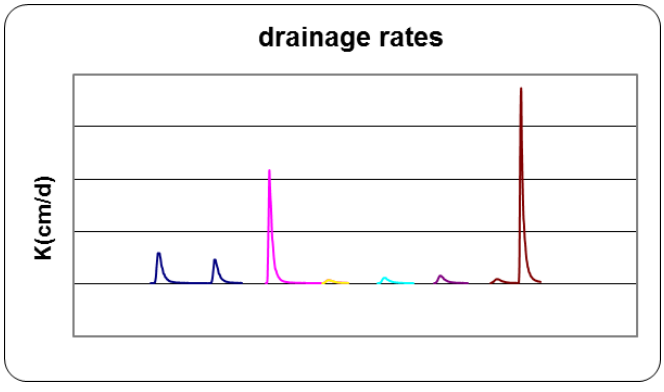

Figure 1 Drainage rates using unsaturated hydraulic properties estimated from soil water monitoring data.

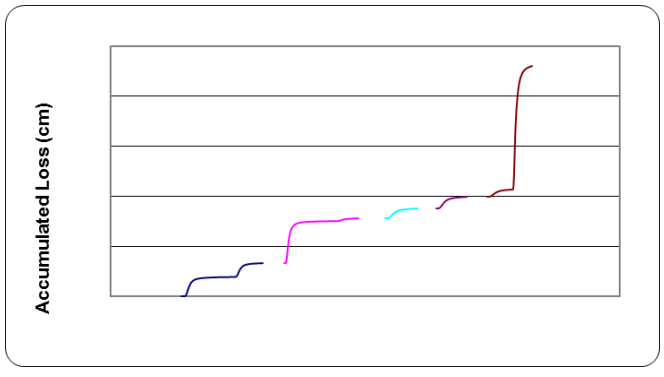

Figure 2 Cumulative drainage by integration of the rates of percolation.

mining the volume of water in a saline seep. Estimating the rate and quantity of the percolating water requires knowledge of the unsaturated hydraulic properties of the subsurface materials. Traditionally, insitu field tests are used or undisturbed cores are obtained for laboratory analysis to determine this. Both methods are time consuming and expensive to implement. This webinar proposed using soil water monitoring data obtained on site to estimate hydraulic properties and to use those properties to estimate deep percolation. The proposed method was demonstrated using unsaturated hydraulic properties ($K(\Theta)$) obtained below a site vegetated with short grass and irrigated daily. Figure 1 shows the rate of percolation, using the unit gradient assumption $K(\Theta)$ with time and Figure 2 shows the accumulative drainage over a period obtained by integrating the percolation rates.

Our next webinar is TBA. Keep a look out for an email with more details. Please visit https://mn.water.usgs.gov/uzig/webinars.htm for more information.

Anyone who would like to present research at an upcoming webinar, or who has a suggestion for possible presenters or topics, should contact Kim Perkins (kperkins@usgs.gov).

Featured Publications

Our members continue to publish research on a wide range of phenomena, theory, and data-collection and analysis techniques related to the unsaturated zone. We had 24 recent publications authored or co-authored by UZIG members. Listed below are the publications from fall 2016 to spring 2017 that were submitted by members (plus a few from 2014–2015). A running compilation of publications featured in each newsletter is available on the UZIG website: http://mn.water.usgs.gov/uzig/links.htm. Now that we have caught up with our publications from the past couple years, we will be featuring only the most recent publications that have been published since the last newsletter (over the last six months).
"Featured Publications" highlights recently published work (for example, an article, book, or technical report) of UZIG members. The guidelines for listing of a publication are as follows:

- At least one of the authors or coauthors must be a UZIG member
- Publication must have been published in the last approximately six months
- Content must be directly related to unsaturated-zone research topics
- Only the publication citation is listed (no reviews or other comments)
- Citations are listed in alphabetical order by first author's last name

Please email Andy O'Reilly (aoreilly@olemiss.edu) any citations (including DOI, if available) for your work meeting these criteria that you would like to be included in an upcoming newsletter.

Chen, P, BB Mirus. N Lu, JW Godt, 2017. Effect of hydraulic hysteresis on the stability of infinite slopes under steady infiltration. Journal of Geotechnical and Geoenvironmental Engineering 143:9, doi: 10.1061/(ASCE)GT.1943-5606.0001724

Cihan, A., J. Birkholzer, T.H. Illangasekare and Q.Zhou, 2014. A Modeling Approach to Represent Hysteresis in Capillary Pressure-Saturation Relationship Based on Fluid Connectivity in Void Space, Water Resources Research, 50, 119-131, doi: 10.1002/2013WR014280

Davarzani, H., K.M. Smits, R. Tolene and T.H. Illangasekare, 2014. Study of the effect of wind speed on evaporation from soil through integrated modeling of atmospheric boundary layer and shallow subsurface, Water Resources Research, doi: 10.1002/2013WR013952

Delin, G. N., and Herkelrath, W. N., 2017. Effects of crude oil on water and tracer movement in the unsaturated and saturated zones. Journal of Contaminant Hydrology, 200, 49-59. doi: 10.1016/j.jconhyd.2017.03.007

Diodato, N., G. Bellocchi, N. Romano, and F.M. Guadagno, 2016. Modelling the rainfall erosivity of the Rhone region (South-eastern France) associated with climate variability and storminess. Adv. Meteorology, Article ID 7626505, 2016:1-9, doi: 10.1155/2016/7626505

Diodato, N., S. Higgins, G. Bellocchi, F. Fiorillo, N. Romano, and F.M. Guadagno, 2016. Hydro-climatic forcing of dissolved organic carbon in two boreal lakes of Canada. Sci. Total Env. 571:50-58, doi: 10.1016/j.scitotenv.2016.07.112

Ebel, B.A., and J.A. Moody, 2017. Synthesis of soil-hydraulic properties and infiltration timescales in wildfire-affected soils, Hydrological Processes, 31, 324–340, doi: 10.1002/hyp.10998

Ghanbarian, B., A. G. Hunt, 2017. Improving unsaturated hydraulic conductivity estimation in soils via percolation theory, Geoderma 303:9-18, doi: 10.1016/j.geoderma.2017.05.004

Ghanbarian, B., A. G. Hunt, T. H. Skaggs, and N. Jarvis, 2017, Upscaling soil saturated hydraulic conductivity from pore throat characteristics, Advances in Water Resources. doi: 10.1016/j.advwatres.2017.03.016

Grimm, R.E., D.E. Stillman, C.L. Dinwiddie, R.N. McGinnis, and S.K. Sandberg, 2017. On conductive ground: Analysis of 'Bistatic sounding of the deep subsurface with ground penetrating radar − experimental validation' by V. Ciarletti et al.,

Planetary and Space Sci. 139:51-56. doi: 10.1016/j.pss.2017.02.010
Hinckley, E.-L.S., B.A. Ebel, R.T. Barnes, S.F. Murphy, and S.P. Anderson, 2017. Critical zone properties control the fate of Nitrogen during experimental rainfall in montane forests of the Colorado Front Range, Biogeochemistry, 132, 213-231, doi: 10.1007/s10533-017-0299-8
Hunt, A. G., and B. Ghanbarian, 2016, Percolation Theory for Solute Transport in Porous Media: Geochemistry, Geomorphology, and Carbon Cycling, Water Resources Res. 52:7444-7459, doi: 10.1002/2016WR019289
Hunt, A. G., R. Holtzman, and B. Ghanbarian, 2017, A Percolation-Based Approach to Scaling Infiltration and Evapotranspiration, Water 9(2):104, doi: 10.3390/w9020104
Knierim, K.J., Pollock, E.D., Covington, M.D., Hays, P.D., and Brye, K.R., 2017. Carbon cycling in the mantled karst of the Ozark Plateaus, central United States, Geoderma Regional 10:64-76, doi: 10.1016/j.geodrs.2017.05.004
McCarter, C.P.R., S. Kettcheson, T.K.D. Weber, S. Scarlett, P. Whittington, and J.S. Price, 2017. A modified technique for measuring unsaturated hydraulic conductivity in Sphagnum moss and peat, Soil Science Society of America Journal, accepted, doi: 10.2136/sssaj2017.01.0006
Mori, H., T. Sakaki, and T.H. Illangasekare, 2015. Laboratory study of geological carbon sequestration using surrogate fluids: Dielectric measurement and scaling of capillary pressure–saturation relationships, International Journal of Greenhouse Gas Control 37:146-157, doi: 10.1016/j.ijggc.2015.01.023
Mori, H., L. Tervisan, and T.H. Illangasekare, 2015. Evaluation of relative permeability functions as inputs to multiphase flow models simulating supercritical CO2 behavior in deep geologic formations, International Journal of Greenhouse Gas Control 41:328-335, doi: 10.1016/j.ijggc.2015.05.023
Nasta, P., and N. Romano, 2016. Use of a flux-based field capacity criterion to identify effective hydraulic parameters of layered soil profiles subjected to synthetic drainage experiments. Water Resour. Res. 52:566-584, doi: 10.1002/2015WR016979
Petri, B. G., R. Fučík, T. H. Illangasekare, K. M. Smits, J. A. Christ, T. Sakaki, C. C., 2015. Effect of NAPL source morphology on mass transfer in the vadose zone, Groundwater, 53(5):685-698, doi: 10.1111/gwat.12284
Poate, J., Illangasekare, T.H, H. Kazimi, R. Kee, 2015. Pore Scale Phenomena - Frontiers in Energy and Environment, World Scientific Series in Nanoscience and Nanotechnology, v. 10, 492 p.
Romano, N., and P. Nasta, 2016. How effective is bimodal soil hydraulic characterization? Functional evaluations for predictions of soil water balance. Eur. J. Soil Sci. 67 (4):523-535, doi: 10.1111/ejss.12354
Romano, N., G.P. Lignola, M. Brigante, L. Bosso, and G.B. Chirico, 2016. Residual life and degradation assessment of wood elements used in soil bioengineering structures for slope protection. Ecological Engineering 90:498-509, doi: 10.1016/j.ecoleng.2016.01.085
Seltzer, A. M., Severinghaus, J. P., Andraski, B. J., and Stonestrom, D. A., 2017, Steady state fractionation of heavy noble gas isotopes in a deep unsaturated zone: Water Resources Research, vol. 53, doi: 10.1002/2016WR019655
Stellato, L., B. Di Rienzo, E. Di Fusco, M. Rubino, F. Marzaioli, V. Allocca, A. Salluzzo, J. Rimauro, N. Romano, F. Celico, 2016. Surface water-groundwater connectivity implications on nitrate cycling assessed by means of hydrogeologic and isotopic techniques in the Alento river basin (Salerno, Italy): Preliminary data. Rendiconti Online Societa Geologica Italiana, 41:80-83.
Vereecken, H., A. Schnepf, J.W. Hopmans, M. Javaux, D. Or, T. Roose, J. Vanderborght, M. Young, W. Amelung, M. Aitkenhead, S.D. Allison, S. Assouline, P. Baveye, M. Berli, N. Brüggemann, P. Finke, M. Flury, T. Gaiser, G. Govers, T. Ghezzehei, P. Hallett, H.J. Hendricks Franssen, J. Heppell, R. Horn, Huisman J.A., Jacques D., Jonard F., S. Kollet, F. Lafolie, K. Lamorski, Leitner, A. McBratney, B. Minasny, C. Montzka, W. Nowak, Y. Pachepsky, J. Padarian, N. Romano, K. Roth, Y. Rothfuss, E.C. Rowe, A. Schwen, J. Šimůnek, J. Van Dam, S.E.A.T.M. van der Zee, H.J. Vogel, J.A. Vrugt, T. Wöhling, I.M. Young, 2016. Modeling soil processes: Key challenges and new perspectives. Vadose Zone J. 15(5):1-57, doi: 10.2136/vzj2015.09.0131
Weber, T.K.D, S.C. Iden, and W. Durner, 2017. Unsaturated hydraulic properties of Sphagnum moss and peat reveal trimodal pore-size distributions, Water Resources Research, 53, 415–434, doi: 10.1002/2016WR019707
Wilson, G.V., John L. Nieber, G.A. Fox, SM Dabney, M. Ursic, and J.R. Rigby. 2017. Threshold Behavior of Catchments with Duplex Hillslope Soils Feeding Soil Pipe Networks. Hydrol. Proc., doi: 10.1002/hyp.11212
Wilson, G.V., R.R. Wells, R. Kuhnle, G.A. Fox, and J. Nieber. 2017. Sediment detachment and transport processes associated with internal erosion of soil pipes. State of Science. Earth Surface Proc. Landforms, doi: 10.1002/esp.4147
Wilson, G.V., S.M. Dabney, and J.R. Rigby. 2017. Data from: Threshold Behavior of Catchments with Duplex Hillslope Soils Feeding Soil Pipe Networks. NAL-Ag Data Commons. doi: 10.15482/USDA.ADC/1339134
Yu, F., and A. G. Hunt, 2017, Damköhler number input to transport-limited chemical weathering and soil production calculations, Earth and Space Chemistry. doi: 10.1021/acsearthspacechem.6b00007

Humor Corner

"Piled Higher and Deeper" by Jorge Cham