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Research poster: From lab to basin scale: A Look at changes in evaporative and transpirative processes in arid and semi-arid shallow groundwater systems

Jeremy E. Koonce  
*University of Nevada, Las Vegas*

Michael H. Young  
*Desert Research Institute*

Dale A. Devitt  
*University of Nevada, Las Vegas, dadevitt@unlv.nevada.edu*

Zhongbo Yu  
*University of Nevada, Las Vegas, zhongbo.yu@unlv.edu*

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From Lab to Basin Scale: A Look at Changes in Evaporative and Transpirative Processes in Arid and Semi-arid Shallow Groundwater Systems

Jeremy E. Koonce1,2, Michael H. Young3, Dale Devitt4, Zhongbo Yu5
1Department of Geosciences, University of Nevada Las Vegas, NV
2Division of Hydrologic Sciences, Desert Research Institute, Las Vegas, NV
3School of Life Sciences, University of Nevada Las Vegas, NV

Background and Motivation

- Soil water evaporation and plant transpiration, collectively known as evapotranspiration (ET), are important to both the surface energy balance and hydrologic cycle, particularly in arid and semi-arid regions.
- With the potential for decreased precipitation from climate change (Barnett and Pierce, 2007) and increased demand for water resources, understanding forces that drive ET and water balance components is required.
- Southern Nevada Water Authority (SNWA) is studying the feasibility of pumping groundwater from valleys in central Nevada to meet the needs of its citizens.
- Decreasing groundwater levels within the Great Basin alluvial and carbonate aquifer systems could change the amount of water distributed between the phreatic and vadose zones.
- Linking moisture content, water potential, and thermal gradients to the ET rates could provide an important connection between above- and below-ground processes, improving the prediction of long-term water resources.

Objectives

- Use an innovative technology to look at water and thermal balances by measuring the temperature responses using PVC wrapped with fiber optic (FO) cable and distributed temperature sensing (DTS) in borings at two test sites:
  1. Valley basins in Spring and Snake Valleys, NV, and
  2. Lysimeter facility in Boulder City, NV;
- Determine changes in the amount of sensible and latent heat released or absorbed from shallow groundwater sources;
- Measure vertical soil moisture and potential gradients to determine the direction and rate of soil water movement; and
- Pending approval of an instrument fellowship (Decagon Devices), determine if recharge to the basin-fill aquifer occurs within the valley floor.

FO DTS Instrumentation

- FO DTS wrapped pole and thermistors will measure temperature in upper phreatic, capillary, and vadose zones with spatial resolution of 1 mm and temperature resolution up to 0.01 C.
- TDRs and HDUs will measure water content and water potential as a function of depth (already installed in Spring Valley, NV).
- Pending approval of instrumentation fellowship (Decagon), one Drain Gauge, three STE Soil Moisture, EC, Temp Sensors and three MPS-1 Dielectric Water Potential Sensors will be installed at each site to determine whether recharge occurs through the valley floors.
- Groundwater levels monitored with pressure transducer, linking groundwater fluctuations to changes in temperature (using the DTS pole), and ET processes (using Eddy Covariance [EC] towers and Heat Flux Plates).
- Data collected from instrument array would support corrected water and energy budget calculations that will in turn provide important information for hydrologic modeling.

Schematic of planned instrument setup to measure ET processes in Spring and Snake Valleys, NV

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References


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Lysimeter Facility

- Located in Boulder City, NV, approx. 40 km southeast of Las Vegas.
- Built to house 4 weighing lysimeters, each equipped with multiple sensors to observe wetting front position, water content, soil heat flux, and thermal regimes.
- In addition to the nested measurement technologies, the lysimeters were installed with FO DTS (two types) to measure temperature.

Schematic of FO DTS setup: AFL (Orange) and BRUGG (Blue) cable

- Time period from 16 Jan at 0000 (Hour 0) through 23 Jan at 1200 (Hour 180). The AFL FO DTS wrapped pole provides temperature data at a vertical resolution of 1-17 cm per meter of FO cable.
- AFL FO cable shows diel temperature responses with variations damped with depth and peaks shifted with time.
- Infiltration of cold precipitation observed after large rainfall occurred near Hour 90. During the time interval of Hour 110 to 156, diurnal temperature variations dampened due to increase in volumetric heat capacity (caused by increase in soil moisture).
- FO DTS wrapped pole has the potential to provide good response to changes in temperature caused by changes in water content.