Wetting Front News

Soil and Water Management Research News

USDA-ARS Conservation and Production Research Laboratory
P.O. Drawer 10 • Bushland, Texas 79012-0010 U.S.A.
(806) 356-5724 • FAX (806) 356-5750 • 2300 Experiment Station Road

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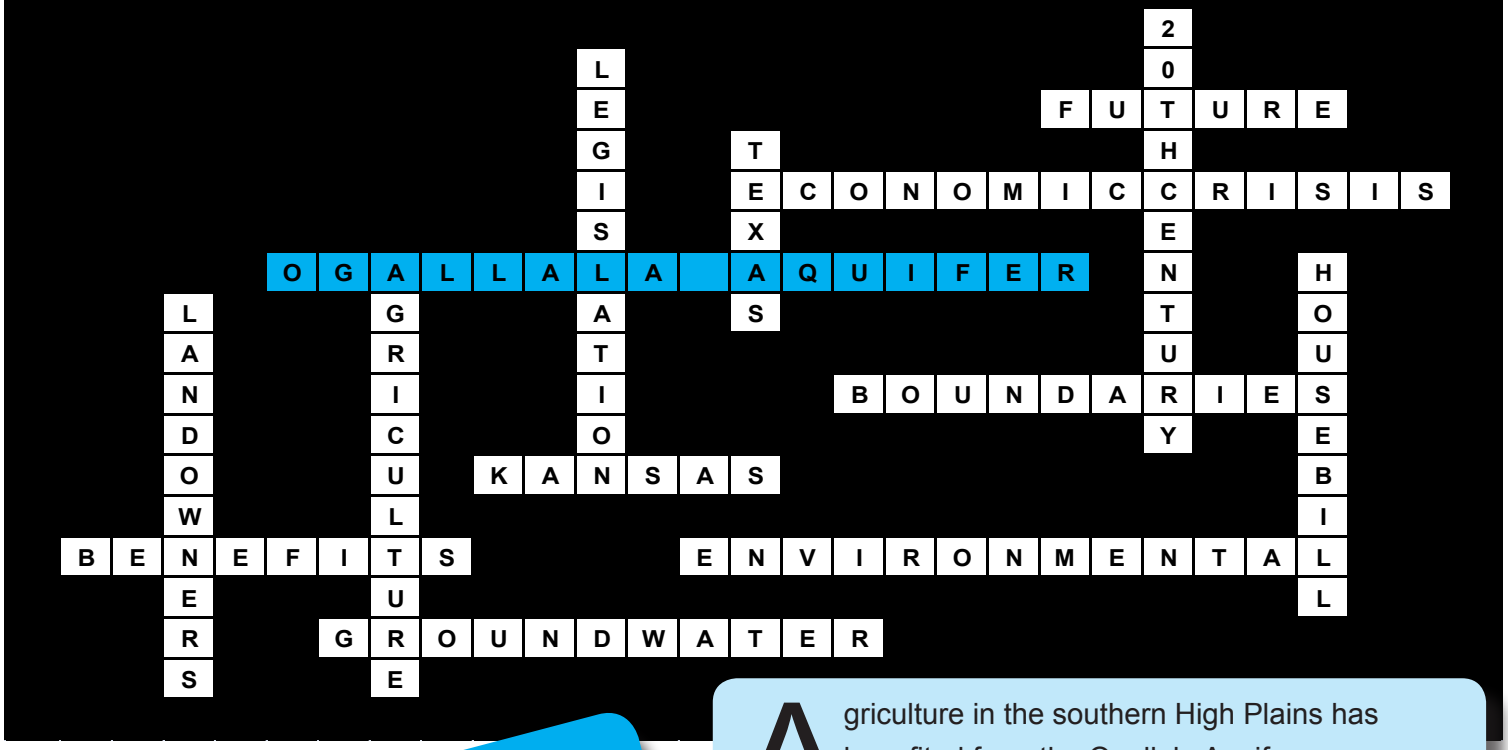
In This Issue

Puzzled? What is the best answer?

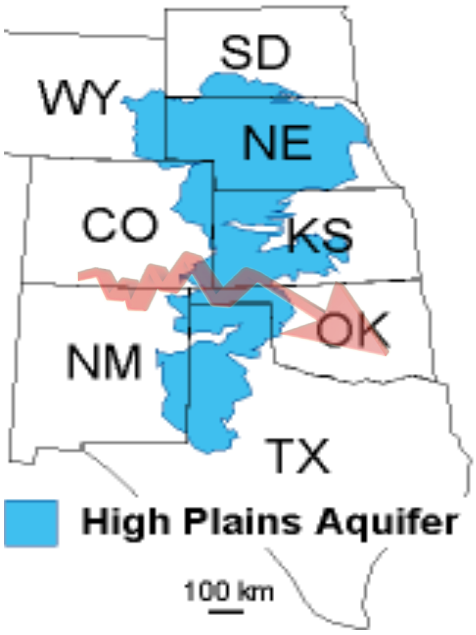


Desired Future Conditions in Texas: What is it about and why should agricultural researchers care?

By David K. Brauer

Agriculture in the southern High Plains has benefited from the Ogallala Aquifer as a relatively inexpensive source of water for irrigation. Irrigation has added greatly to farm income. A recent study supported by the Ogallala Aquifer Program (OAP) estimated that irrigation will add almost $1,000 per acre in value in the next 50 years (2006 OAP Accomplishment Report). However, the water in the Ogallala Aquifer is a finite resource, that is, water removed today, or in the past, will not be available in the future. The same study mentioned above estimates that water in the Ogallala Aquifer, on average, will decline by almost 50% in the next 50 years if no water conservation strategies are implemented. On a county level, decline in the aquifer is estimated to range from 0 to 90% depending on withdrawal for irrigations and beginning levels of saturated thickness. With decreases in aquifer water, annual water use is expected to decline by 75% over the next 50 years. The receipts from irrigated agriculture have sustained rural economies and thus the communities themselves. Continued sustainability for these rural communities is directly tied to the efficient use of Ogallala Aquifer water in the future.

To avoid an immediate economic crisis brought about declining aquifer levels, states, like Kansas, have enacted laws that restrict water use. Although Kansas recognizes water rights as a real property attached to the land, the Kansas Water Appropriation Act states that all surface water and groundwater within Kansas are for use by the people of the state, thus subject to control and regulation by the state. Water rights in Texas, however, are quite different from most states. Regarding groundwater, the right of capture is the basic legal principle governing use. The right of capture, in the simplest terms, allows a landowner to utilize the water underneath his property in any way he or she sees fit as long as the use is beneficial or not wasteful. Therefore, there was little control over groundwater use in Texas for most of the 20th century except through locally controlled groundwater district regulations.



In 1997, the Texas legislature passed Senate Bills 1 and 2 as devices to balance landowner's right to capture groundwater with the protection of groundwater as a natural resource. These bills were in response to a particularly severe drought in 1996. The statutes changed the way that the state of Texas conducts water planning and led to the establishment of 16 Groundwater Management Areas (GMA). All 16 GMA needed to develop and submit water plans to the Texas Water Development Board (TWDB). The first of these plans were submitted in 2001. Plans are updated every five years.

Another significant groundwater legislative initiative was passed in 2005 as House Bill 1763. House Bill 1763 established a framework for regional collaboration among local groundwater districts (GWD) residing over a common aquifer within a GMA to set Desired Future Conditions (DFC). A DFC is a target for the amount of water left in an aquifer 50 years in the future. Once DFC are established, the TWDB will determine how much groundwater is available and then the GWD will need to establish rules to ensure that the withdrawals do not exceed what is available. Texas statute requires the GMAs to submit DFC to TWDB by September 1, 2010. DFC are to be incorporated into the current round of regional water planning (2007 – 2012). To meet these deadlines, most GMA have been working since 2007 to establish their DFC. The October 2009 issue of "The Cross Section", a monthly publication of the High Plains Underground Water Conservation District No. 1, has additional information on DFC and House Bill 1763. An electronic copy of the publication can be obtained from http://www.hpwd.com/CrossSection/10-2009%20Cross%20Section.pdf.

Water rights in Texas are quite different from most states.

The rest of this article will focus on the latest activities occurring in GMA#1 regarding the establishment of DFC. GMA#1 comprises the 17,000 square miles of the 21 northern most counties of the Texas Panhandle. The four GWD within GMA 1 are: Panhandle Groundwater Conservation District (PGCD), North Plains Groundwater Conservation District (NPGCD), Hemphill County Underground Water Conservation District (HCUWCD) and part of High Plains Underground Water Conservation District (HPUWCD). The Panhandle Water Planning Group (PWPG) was formed in accordance to Senate Bills 1 and 2 to create

regional level water plans. The four GWD and PWPG have been conducted numerous stakeholder meetings and joint discussions starting in 2007 and continued through 2009 in an effort to set DFC for GMA#1. These meetings and activities culminated in July 2009 with the PWPG submitting to the TWDB a DFC for GMA#1.

The submitted statement defined three DFC for three sub-areas within GMA#1. These sub-areas essentially were defined by county boundaries. The DFC for the four northwestern counties in PGCD were set at 40% of the water remaining in the Ogallala Aquifer in 50 years. For the rest of PGCD, and all of NPGCD and HPUWCD, the DFC were set at 50% in 50 years. For HCUWCD, DFC were 80% in 50 years. Earlier in the process, HPUWCD had advocated a DFC of 90% for its area.

A petition filed by Mesa Water LP and G&J Ranch, Inc. filed a petition against the adoption of the DFC. A hearing was held on Nov. 11, 2009 in Amarillo, TX in which both the petitioners and representatives of PWPG presented arguments opposing and in support of the proposed DFC. The information in the following paragraphs is from my notes taken during the hearing.

Petitioners argued that the boundaries of the sub-areas for different DFC within GMA#1 did not conform to the statute's description. The statute specifies that sub-areas for DFC within GMA can be set because of hydrologically and geologically distinct sub-basins within the aquifer or by unique geographic areas. A hydrologist testifying for the petitioners provided evidence that the aquifer characteristics were similar between areas with different proposed DFC. Representatives of PWPG did not provide rebuttal data for this point. Petitioners further argued that the sub-areas with different proposed DFC did not constitute distinct geographic areas, because the different sub-areas were drawn along political boundaries. The petitioner expanded this argument to state that if the Texas legislation wanted DFC defined along political borders then such language would have been included in the House Bill. Representatives of PWPG argued in rebuttal that the areas with different DFC represented geographic areas with different historical water use. The sub-area with the proposed 40% DFC in 50 years is the sub-region within GMA#1 that has historically had withdrawals that constituted over 50% of the total withdrawals for GMA#1. On the other hand, the area within HPUWCD has little irrigated agriculture and stakeholders within the GWD wanted a DFC that would maintain the area's surface waters and springs.

DFC must also: 1) be physical possible; 2) result in acceptable socio-economical impacts; 3) provide sufficient protection to the environment; and 4) conform to state laws and policies. Petitioners argued that the proposed DFC did not meet at least 3 of these 4 criteria. They stated that 60% withdrawal in 50 years within the sub-area 1 was not physically or economically feasible, thus the proposal was not physically possible. Petitioners said that there were no data to assess the socio-economic impact of the proposed DFC for the entire GMA#1. However, two landowners from HPUWCD testified that they felt that their water was worthless if the proposed DFC of 80% in 50 years was passed because the DFC would limit

their ability to sell their water rights to developers. HPUWCD officials stated that they had a petition signed by at least 100 landowners supporting the 80% DFC. The signed petition also confirmed these landowners' belief that the proposed 80% DFC would make their land and water rights more valuable in the future.

Additionally the petitioners presented the notion that the different proposed DFC in GMA#1 was insufficient to protect natural and environmental attributes to a similar extent. Lastly, the petitioners argued that the different DFC were not constructed along unique hydrological, geological or geographic boundaries and as such did not conform to the statue.

Petitioners further argued that the proposed DFC were not fair and did not provide equal protection to both people and resources within GMA#1. The fairness issue stems from the fact that the different DFC would allow some landowners to develop their water rights to a greater degree than others. Additionally, landowners from the area with the right to deplete 50% of the aquifer in 50 years adjacent to HPUWCD would be utilizing water from the area with a proposed DFC of 80%. The equal protection issue stems from the notion that springs and surface waters connected to the Ogallala Aquifer in areas other than HPUWCD would have less protection under the proposal. PWPG's rebuttal was that equal protection was not an issue for TWDB to decide.

Petitioner's final argument was that House Bill 1763 envisioned that joint planning would occur with a GMA and that the proposed DFC were not the result of joint planning but each GWD acquiescing to the other's GWD proposed DFC. PWPG rebutted by stating that the proposed DFC reflected the desires of local stakeholders, and House Bill 1763 and Senate Bills 1 and 2 envisioned that water planning would be a locally driven process.

The purpose of the hearing was for each side to present their arguments in support or against the proposed DFC and to provide facts for TWDB's consideration. Written comments can be submitted to TWDB for 10 days after the hearing. In February 2010, TWDB will have a further public hearing in Austin, Tex. regarding the proposed DFC before a decision is made. So a final decision regarding DFC in GMA#1 will not be determined until sometime later in 2010.

Independent of the outcome of TWDB's decision regarding DFC in GMA#1, there are developments that should have a bearing on the agricultural research needs for stakeholders in GMA#1. Farmers in the four northwest counties of the GMA will need new management practices that sustain current crop yields with decreasing available water for irrigation. Databases and models that most accurately reflect changes in groundwater levels under various management schemes need to be developed, and the results from such simulations communicated to policy makers and stakeholders. Additional assessments of the socio-economic impact of the adoption of DFC are needed. Current and planned research activities of the Ogallala Aquifer Program, a research and education consortium that includes the Soil and Water Management Research Unit at the CPRL, are addressing new technologies and knowledge that will help both farmers and water planners in sustaining rural Texas Panhandle communities while achieving DFC. ♦

Check out the official website at:

http://ogallala.tamu.edu/

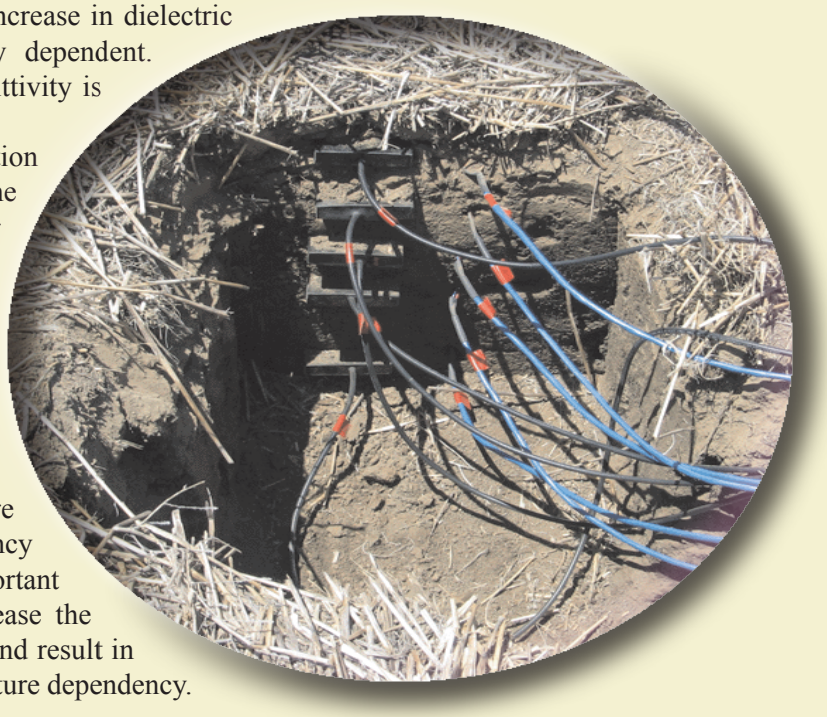
Improved TDR

Soil Water Content Calibrations Using a Physically Based Model

by Robert C. Schwartz, Steven R. Evett, and Jourdan M. Bell

Automated sensing of soil water for use in long-term monitoring applications is customarily completed using electromagnetic instruments such as time-domain reflectometry (TDR). TDR measures the travel time of a broadband pulse along a probe inserted into the soil to estimate soil water content. With a known probe length, the travel time measurement allows calculation of the apparent permittivity of the soil. Permittivity is the ability of a material to polarize in response to an electric field which is manifested by charge storage as in a capacitor. In the absence of conductive and relaxation losses, the dielectric response of soil is governed largely by the permittivity of water which is approximately 16 and 80 times greater than soil minerals and air, respectively. Because of the strong relationship between volumetric soil water content and permittivity, empirical calibrations have been quite successful with the notable exception of fine-textured soils. Most empirical calibrations implicitly assume a linear dependence of water content with travel time and negligible dielectric losses, both of which are invalid in soils with significant quantities of high surface area clays.

Water is a polar molecule (a dipole) and, in liquid form, will readily orient in response to an electric field, giving rise to its relatively large permittivity. Within a variable electric field generated by electromagnetic sensors, polar molecules will oscillate in response to the alternating current provided that the time period associated with signal frequency is not less than the time constant for molecular motions. However, very close to mineral surfaces (< 1 nm), the rotational motions of water molecules are dampened because of the influence surfaces and the associated counterions on the molecular structure of water. Water influenced by surfaces, termed bound water, has a lower permittivity than bulk water in the TDR frequency range. Consequently, at a given water content, soils with large surface areas will exhibit lower real permittivities compared with coarse-textured soils. Concomitant with rotational dampening, bound water will also dissipate some of the field energy leading to an increase in dielectric relaxation losses, which are strongly frequency dependent. An added complication is that bound water permittivity is strongly temperature dependent.



Surprisingly, it is the indirect effects of relaxation losses and not the lower real permittivity that cause the most difficulties with the accurate estimation of water contents in soils with significant quantities of high surface area clays. Attenuation caused by dielectric relaxation increases with increasing frequency and causes the reflected broadband signal, which has a wide frequency range, to lose the high frequency components. Consequently, the effective frequency at which travel time is measured declines. Because both real and imaginary permittivities of the soil are frequency dependent, the decline in effective frequency influences the measured travel time. Equally important is that a decline in effective frequency will increase the contribution of bulk electrical conductivity losses and result in an increase in the apparent permittivity and temperature dependency.

These interrelated processes combine to produce a strongly non-linear relationship between soil water content and travel time. It is therefore not surprising that empirical calibrations are subject to large (>0.05 $m^3 m^{-3}$) errors in soil water content estimates, especially when laboratory calibrations are applied to estimate water content in the field.

Recently, a physically-based dielectric model was introduced by Schwartz et al. (2009a; 2009b) that considers the effects of mineral surfaces on the soil complex permittivity. The Debye model is used to describe two populations of water molecules: those in bulk solution (free water) and those near mineral surfaces (bound water). Volumetric fractions and permittivities of free water, bound water, air and soil are next combined using an electromagnetic mixing formula to approximate the effective macroscopic permittivity of the soil. This permits the apparent permittivity K_a to be written as a function of volumetric water content (θ), soil temperature (T), bulk electrical conductivity (σ_a), bulk density (ρ_b), specific surface area of the soil (A_s), a polarization loss factor (p), and the bandwidth of the TDR signal at the end of the cable (ω_S). Model calibration results in a fitted A_s and p that enables the description of the dielectric response of soils (Fig. 1) and the decline in effective frequency, respectively. With measured values of the remaining parameters, calibrations reflect the degree of sensitivity of apparent permittivity to both temperature and water content (Fig. 2). When the effects of bulk electrical conductivity, bound water, and signal attenuation by the cable are omitted in the model calculations, differences between measured and estimated apparent permittivities become large and correspond to water content errors of up to 0.10 $m^3 m^{-3}$. Application of the calibration to field measurements (Fig. 3) demonstrates how it influences both the magnitude and temperature sensitivity of estimated water contents in comparison with empirical models. Dampening of the temperature induced oscillations by the physically based model permits the detection of increases in water content after small rainfall events which are difficult or impossible to detect using empirical calibrations.

The physically based dielectric model developed at CPRL is a conceptual advance over empirical calibrations and improves our understanding of the factors influencing the accurate estimation of soil water contents in fine-textured soils. Because of considerable relaxation losses in soils with significant quantities of high surface area clays, apparent permittivity in these soils is more sensitive to bulk electrical conductivity, temperature fluctuations, and cable length compared with coarse-textured soils. To a large extent, the model is

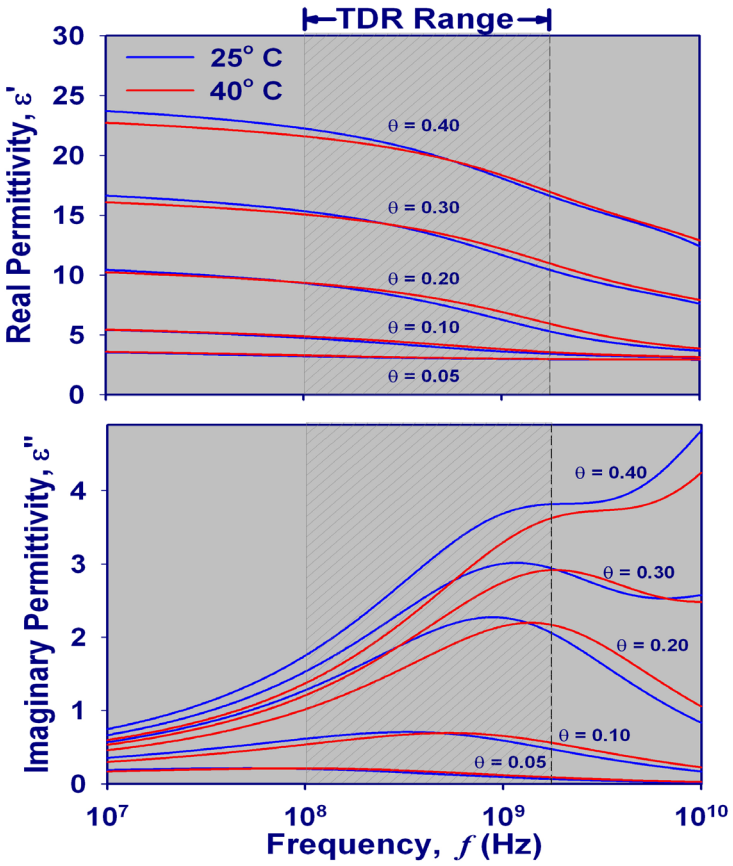


Fig. 1. Simulated dielectric dispersion and absorption curves using the power law mixing model (without DC conductivity contributions) over a range of water contents and at two temperatures for a soil with a specific surface area of A_s = 200 $m^2 g^{-1}$.

The model is able to capture major soil dielectric properties to permit accurate estimation of water content in high surface area soils.

able to capture the major soil dielectric properties and processes associated with travel time measurements in fine-textured soils using TDR. This is partly corroborated by fitted surface areas that are within 10% of measured surface areas. Because of the close correlation between fitted surface area and easily measured soil properties like cation exchange capacity and clay content ($r > 0.95$), spatial variability in soil textural properties can be easily accommodated using the model. Calibrations typically involve only two or three fitting parameters, and, once fitted, a water content accuracy within 0.02 to 0.03 $m^3\ m^{-3}$ can be attained under field conditions.

References

Schwartz, R.C., Evett, S.R., Pelletier, M.G., Bell, J.M. 2009. Complex permittivity model for time domain reflectometry soil water content sensing: I. Theory. Soil Sci. Soc. Am. J. 73:896-897.

Schwartz, R.C., Evett, S.R., Bell, J.M. 2009. Complex permittivity model for time domain reflectometry soil water content sensing: II. Calibration. Soil Sci. Soc. Am. J. 73:898-909.

Schwartz, R.C., R.L. Baumhardt, and T.A. Howell. 2008. Estimation of soil water balance components using an iterative procedure. Vadose Zone J. 7:115-123.

Topp, G.C., J.L. Davis, and A.P. Annan. 1980. Electromagnetic determination of soil water content: Measurements in coaxial transmission lines. Water Resour. Res.16:574-582.

Executable console applications that implement the calibration and water content estimation algorithms based on this work are available from the author upon request. We are working on a windows interface to simplify model use for routine TDR measurements.

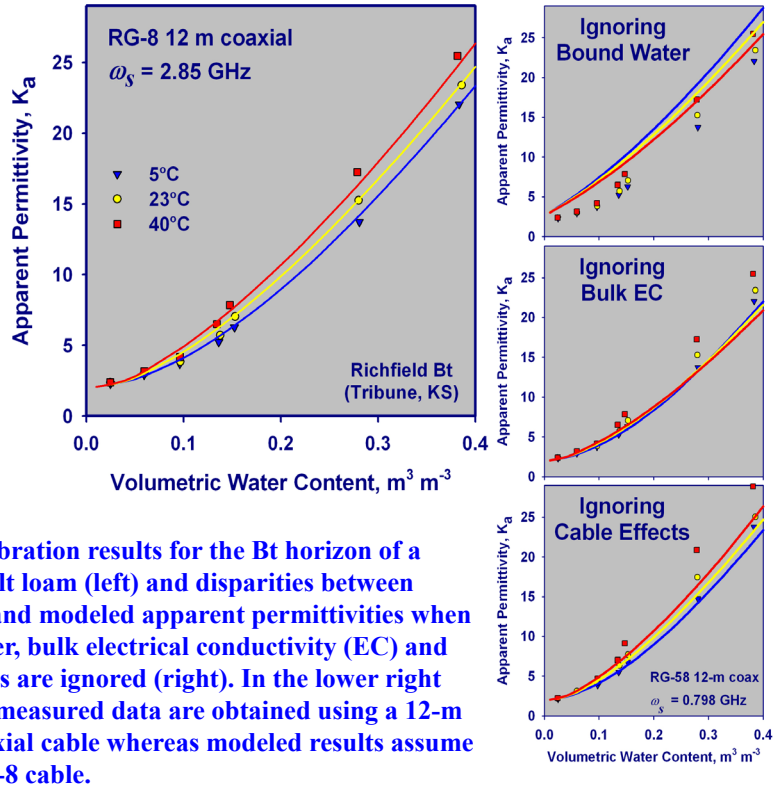


Fig. 2. Calibration results for the Bt horizon of a Richfield silt loam (left) and disparities between measured and modeled apparent permittivities when bound water, bulk electrical conductivity (EC) and cable effects are ignored (right). In the lower right hand plot, measured data are obtained using a 12-m RG-58 coaxial cable whereas modeled results assume a 12-m RG-8 cable.

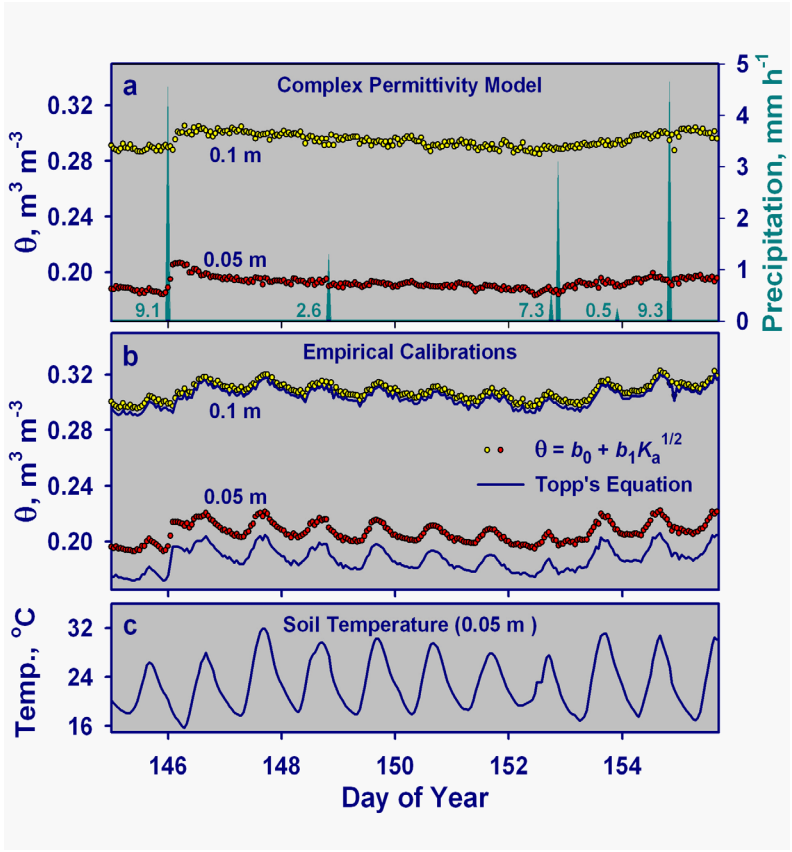
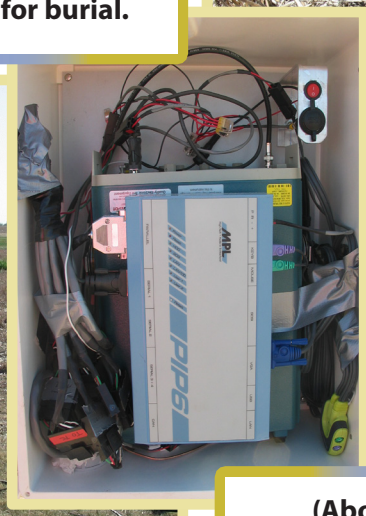


Fig. 3. Field measured soil temperature (c) and precipitation (a) and estimated water contents at two depths (0.05 and 0.1 m) based on the calibrated dielectric mixing model, the square root of permittivity calibration and the Topp et al. (1980) equation. Measurements are for the Pullman Ap horizon in an instrumented field described by Schwartz et al. (2008).

(Below) Dr. Alan Schlegel (left) of Kansas State University and Jourdan Bell (right) of USDA-ARS prepared coaxial cable for burial.



(Above) Installed TDR probes and thermocouples in a no-till field at Tribune, KS

IT ALL STARTS WITH THE WIRING

(Above Center) A fanless, low-power PC (front) is used to control the cable tester (rear) and acquire travel time data.

TDR system setup in Bushland, TX (June, 2009) showing the control units in the grass buffer strip (above) and multiplexers (right, fore-ground).

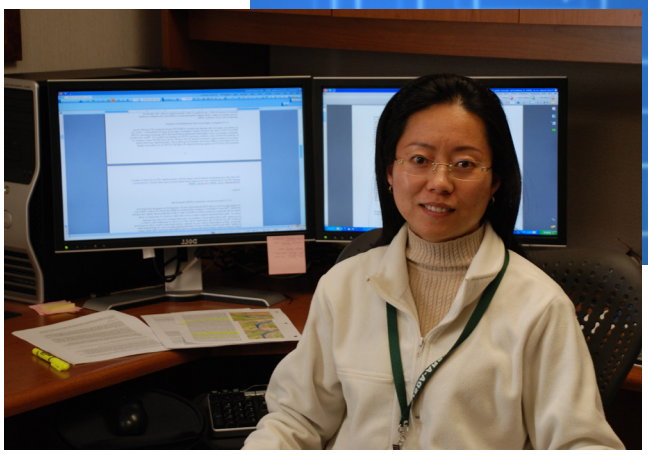
New Agricultural Research

Engineer Looks Forward To Working On Remote Sensing Images

Hello Everyone! My name is Wonsook Ha. I started working at the Conservation & Production Research Laboratory (CPRL) as a research agricultural engineer in August 2009 with Dr. Prasanna Gowda. I am conducting research on downscaling of remotely sensed images for regional evapotranspiration (ET) mapping purposes. Before I joined the Soil and Water Management Research Unit at CPRL, I worked at the U.S. Salinity Laboratory in Riverside, Calif. as a research soil scientist for a research project on perchlorate uptake in vegetables. Perchlorate has been detected in drinking water and leafy vegetables and is a concern due to impairment of thyroid function. Analysis of leafy vegetable has revealed a wide variability in perchlorate concentration. This variability occurs both at the irrigation district level and at the farm level with a fixed concentration of perchlorate in the irrigation water.

I also had an opportunity to work at the University of California-Davis as a post-doc research associate regarding emission study of soil fumigants to monitor and improve air quality in agricultural fields. Measurement of plastic film permeability to soil fumigants was another research project that I worked on for the development of alternative management practices to reduce fumigant volatilization losses from agricultural fields. The mass transfer rates of 1,3-dichloropropene, chloropicrin, iodomethane, and methyl bromide through standard polyethylene tarp, virtually impermeable film, and other commercial films were determined under laboratory conditions using stainless steel permeability cells.

I received a Ph.D. in Soil and Water Science Department at the University of Florida. As part of my Ph.D. dissertation, I developed a numerical model to describe the fate and transport of soil fumigants in plastic-mulched soil beds under non-isothermal conditions. There were a few research findings from that research. First of all, the gaseous methyl isothiocyanate distribution was highly affected by the soil water content distribution in the soil bed. Secondly, inclusion of micrometeorological factors in the model was successful to depict uneven heating of the soil bed during the day time. I performed several field experiments during that time on the fate and transport of soil fumigants.



I am excited to be a part of the Soil and Water Management Research Unit. I am looking forward to working at Bushland at the Conservation & Production Research Laboratory on downscaling of remotely sensed images for regional ET maps.

Technology Transfer

Steve Evett presented the invited talk, “USDA-ARS Irrigation Management Research and Development at Bushland”, to extension agents from western Oklahoma, July 1, 2009.

The Research Unit was visited by Allan Andales and Lane Simmons from Colorado State University on July 22, 2009 to discuss operation and instrumentation of the weighing lysimeters at Rocky Ford, Colorado.

Paul Colaizzi presented a poster “Comparison of SDI with Alternative Irrigation Methods” by P. D. Colaizzi, S. R. Evett, T. A. Howell, and R. L. Baumhardt at SDI Field Day, August 4, 2009, KSU Research and Extension Center, Colby, KS (invited). Attended by producers, crop consultants, agricultural loan officers, research and extension personnel.

Steve Evett presented the invited talk, “Sorghum Automatic Irrigation Control for Improved Water Use Efficiency” to the Sorghum Improvement Conference of North America and Great Plains Sorghum Conference, Amarillo, Texas, August 10-12, 2009.

Susan O’Shaughnessy participated in the training for WaveForum for Wireless Radio Telemetry, August 11-13, 2009, Minneapolis, MN.

Paul Colaizzi presented posters “Comparison of SDI with Alternative Irrigation Methods” by P. D. Colaizzi, S. R. Evett, T. A. Howell, and R. L. Baumhardt, and “Corn Production with Alternative SDI Designs” by P. D. Colaizzi, S. R. Evett, and T. A. Howell at SDI Field Day, August 25, 2009, Texas AgriLife Research and Extension Farm, Halfway, TX (invited). Attended by producers, crop consultants, agricultural loan officers, research and extension personnel.

Steve Evett was visited by Drs. Nazar Ibragimov and Makhmud Butaev from August 22 to September 4, 2009 to develop a proposal for research on crop water use and water use efficiency as affected by limited and no-tillage irrigated cropping rotations and on water quality in the Samarkand watershed, Uzbekistan. Dr. Ibragimov is Head of the Soil Fertility Department of the National Cotton Growing Research Research institute, Tashkent, and Dr. Butaev is a veterinarian with the Uzbekistan Veterinary Research Institute, Samarkand.

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On three weekends in August and September, Boy Scouts led by Eagle Scout candidate Michael Hoy of Troop 87 picked 5600 pounds of potatoes and more than 100 watermelons for delivery to the Amarillo Food Bank in cooperation with Steve Evett and Dr. Charlie Rush of Texas AgriLife Research. The produce was from fields managed by Dr. Rush. (*For a complete story see Farmers’ Markets Today magazine, Jan/Feb 2010 issue, pg 20.)*

Paul Colaizzi discussed irrigation system research with the Amarillo Chamber of Commerce Agricultural Committee field tour at CPRL on August 26, 2009.

On September 23, 2009 the Research Unit was visited by Gabriele Bonaiti with Northern Irrigation from Italy and Ali Mhammed (Head, Soil Fertility Dept) and Husham Al-Obaidi, (Head, Soil Chemistry Department) from the Iraqi Ministry of Science and Technology. Mhammed and Al-Obaidi were in the U.S. for two months as USDA Borlaug Fellows studying irrigation and salinity from the Ministry of Science and Technology, Baghdad, Iraq for talks on irrigation management, soil water sensing and measurement, and crop water use measurement with weighing lysimeters and modeling.

Susan O'Shaughnessy participated at the Top of Texas Career Expo on October 21, 2009. The purpose was to have a career discussion with high school juniors from schools around the Texas Panhandle. She spoke to students about potential science careers with ARS, student worker positions after high school graduation at CPRL, she handed out ARS magazines, ARS career pamphlets, and ARS give-aways. There were 980 juniors, 20 schools, 45 exhibitors in attendance at the First United Bank Center, West Texas A & M in Canyon, Texas.

Steve Evett worked with the 4th grade at Bushland Elementary School on building with adobe, November 12th and 19th, 2009

On November 20, 2009, Steve Evett was visited by J.D. Booker, Texas Tech University, to discuss modeling of cotton water balances in a watershed context.

Susan O'Shaughnessy and Jourdan Bell participated for the 2nd year at WISE (Woman In Science Endeavors) on November 14, 2009 at ACAL in Amarillo, Texas. Beads and Biofuels was presented by Susan, Groundwater Model Information was presented by Jourdan. Approximately 100 middle school girls from around the Pandhandle participated.

Steve Evett worked with scientists and engineers of the National Centre for Agricultural Research and Extension, Amman, Jordan on weighing lysimeter data from the Jordan Valley to compute crop coefficients for irrigation scheduling of sweet corn and tomato and to compare evapotranspiration as measured by weighing lysimeter and eddy covariance systems, December 10-21, 2009. (right)

The weighing lysimeter at the Deir Alla Research Station of NCARE was planted to onion in December 2009 (left). The lysimeter is at 224 m below sea level in the "natural green house" of the Jordan Valley and was completed in 2008 by an NCARE team (Drs. Naem Mazahreh and Mohammed Jitan, and Engineer Mahmoud Sawalha) working with Steve. Steve also visited Nazareth, Israel (above) to speak at the Olive Irrigation and Oil Quality Symposium, Dec. 6-10, 2009.

Texas High Plains Evapotranspiration Network
TXHPET

Check it out: Texas High Plains ET Network

http://txhighplainset.tamu.edu/

Station Welcomes Local & International Visitors

Amarillo, Texas

Washington D.C.

Uzbekistan

Iraq

Australia

Mexico

Spain

Italy

Pictured clockwise: 1) Acting Director, Terry Howell & Gary Molberg with the Amarillo Chamber of Commerce 2) Two Representatives from Senator Kay Bailey Hutchinson's office 3) Nazar Ibragimov with National Cotton Growing Research Research Institute 4) Makhmud Butaev with Uzbekistan Veterinary Research Institute 5) Ali Mhammed, Soil Fertility Dept. and Husham Al-Obaidi, Soil Chemistry Department from the Iraqi Ministry of Science & Technology 6) Mohsin Hafeez with the International Centre of Water for Food Security 7) Roberto Avila, The Autonomous University of Zacatecas 8) Sergio Contreras Lopez with Bureau of Economic Geology, University of Texas at Austin 9) Gabriele Bonaiti with Northern Irrigation of Italy.

Steve Evett was invited by the USDA Graduate School to present "Irrigation control to improve water use efficiency – Middle Eastern and U.S. perspectives" at a symposium in Fort Collins, CO for a Sustainable Agriculture International Visitor Leadership Program (IVLP) for Iranian agricultural professionals on July 16, 2009.

On July 22, 2009, Dr. Allan Andales and Lane Simmons from the Colorado State University research station at Rocky Ford, CO visited the Bushland facilities to discuss lysimeter operations.

On August 4 and 26, 2009, Drs. Terry Howell, David Brauer, and Paul Colaizzi participated in the OAP SDI Technology Transfer Field Days at Colby, KN, and Halfway, TX, respectively. Paul Colaizzi made a presentation.

Abstract from Field Day meeting:
P.D. Colaizzi, S.R. Evett, T.A. Howell, and R.L. 2009. Baumhardt. Comparison of SDI with Alternative Irrigation Methods.

On August 6, 2009 Dave Brauer led an OAP Leadership meeting at Bushland, TX.

On August 10, 2009, Terry Howell participated in a sorghum research meeting with ARS, Texas AgriLife Research, and the sorghum industry to identify future research needs and to enhance future collaboration.

On August 11-12, 2009, Drs. Judy Tolk, Terry Howell, and David Brauer participated in the Sorghum Improvement Conference of North America held at the Amarillo Texas AgriLife Research and Extension Center.

Drs. Paul Colaizzi, Steve Evett, Terry Howell and Susan O'Shaughnessy attended the Subsurface Drip Irrigation Field Day at Halfway, TX on August 25, 2009. The field day was attended by producers, crop consultants, agricultural loan officers, research and extension personnel. Paul Colaizzi made a presentation.

Abstracts from Field Day meeting:

P. D. Colaizzi, S. R. Evett, T. A. Howell, and R. L. Baumhardt. 2009. Comparison of SDI with Alternative Irrigation Methods

P.D. Colaizzi, S.R. Evett, and T.A. Howell. 2009. Corn Production with Alternative SDI Designs.

On August 26, 2010, Drs. R. Nolan Clark and Terry Howell made presentations on current and future agricultural research issues to the Amarillo Chamber of Commerce meeting held at the CPRL.

On September 15, 2009, Paul Colaizzi made a presentation at KSU - Northwest Cotton Growers Co-Op Gin Field Day, at the Ron Lucas Farm in Moscow, KS. It was attended by producers, crop consultants, research and extension personnel.

Abstract from Field Day meeting:

P.D. Colaizzi, S.R. Evett, T.A. Howell, and R.L. Baumhardt. 2009. Cotton Production with Spray, LEPA, and SDI.

On September 16, 2009, Terry Howell participated in the USDA-ARS Hall of Fame Induction Ceremony for Dr. B.A. Stewart, former CPRL Laboratory Director, at the ARS Arboretum in Washington, D.C. and met with Dr. Michael Shannon, National Program Leader, for Natural Resources and Sustainable Agricultural Systems on September 17, 2009.

Susan O'Shaughnessy participated in the Texas ASABE Section Meeting, October 18, 2009, Lubbock, TX.

On October 20-22, 2009, Drs. Dave Brauer and Prasanna Gowda attended a workshop in Zacatecas City, Zacatecas, Mexico entitled "Enhancing water use efficiency and sustainability of the Calera Aquifer: Decision-Maker Information need and Policy Options." Other attendees included representatives from the ARS El Reno, OK, University of Georgia, Texas AgriLIfe Research / TAMU, Universidad Autonoma de Zacatecas, Instituto Mexicano de Technologia del Agua, Instituto Nac de Invest Forestales Agricolas y Pecuarias, USAID, and USDA/ Foreign Agricultural Service. The objective of the meeting was to define a work plan to assess the water resources of the Calera Aquifer and develop management tools for water use planners can use.

Robert Schwartz presented an invited talk at the ASA-CSSA-SSSA Meetings in Pittsburg, PA, November 1-5, 2009 entitled "A Complex Permittivity Model for Field Estimation of Soil Water Content Using TDR".

Paul Colaizzi made a presentation during the BEAREX08 session at the ASA-CSSA-SSSA Annual Meeting, November 2, 2009, Pittsburgh, PA.

Abstract from the BEAREX09 session:

P. D. Colaizzi, W. P. Kustas, S. R. Evett, T. A. Howell, and P. H. Gowda. 2009. A Dual-Temperature-Difference Approach to Estimate Daytime Sensible and Latent Heat Fluxes under Advective Conditions.

Drs. Paul Colaizzi, Steve Evett, Prasanna Gowda, Robert Schwartz, Judy Tolk, Susan O'Shaughnessy and Technicians, Jourdan Bell and Luke Britten attended the American Society of Agronomy Annual Meeting, November 3, 2009, Pittsburgh, PA.

Abstracts from meeting in Pittsburgh, PA (CD-ROM):

Agam, N., S.R. Evett, J.A. Tolk, and W.P. Kustas. 2009. Evaporative Loss from the Interrow of Irrigated Crops in a Semi-Arid Agricultural Area.

Anderson, M.C., W.P. Kustas, C.M.U. Neale, J.H. Prueger, D.G. Williamson, S. Evett, J.L. Chavez, and P. Gowda. 2009. Mapping Evapotranspiration and Moisture Stress in an Advective Environment Using Multi-Scale Thermal Remote Sensing Data.

Baumhardt, R.L., Schwartz, R.C., Macdonald, J.C., Greene, L. Tillage and grazing effects on yields of a dryland wheat-sorghum-fallow rotation.

Chávez, J.L., W.P. Kustas, P.H. Gowda, T.A. Howell, J.H. Prueger, L.E. Hipps, S.A. O'Shaugnessy, P.D. Colaizzi, S.R. Evett, C.M.U. Neale, M.C. Anderson, and K.S. Copeland. 2009. Aerodynamic Temperature Derived from Flux-Profile Measurements and Two-Source Model Predictions over a Cotton Row Crop in an Advective Environment.

Colaizzi,, P., W.P. Kustas, S.R. Evett, T. Howell and P. Gowda. 2009. A Dual-Temperature-Difference Approach to Estimate Daytime Sensible and Latent Heat Fluxes Under Advective Conditions During BEAREX08.

Colaizzi, P.D., W.P. Kustas, S. Evett, T.A. Howell, and P.H. Gowda. 2009. Daily Evapotranspiration Estimates by Scaling Instantaneous Latent Heat Flux Derived From a Two-Source Model.

Evett, S.R., W.P. Kustas, P.H. Gowda, and T.A. Howell. 2009. Overview of BEAREX08, A Remote Sensing Field Experiment On ET at Field, Multi-Field and Regional Scales Using Measurements and Models.

Gowda, P., Chavez, J.L., Colaizzi, P.D., Howell, T.A. 2009. Remote sensing for crop water use management: Present status and challenge.

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Publications

Chávez, J.L., **P.H. Gowda, T.A. Howell**, L.A. Garcia, and **K.S. Copeland**. 2009. Mapping ET at high resolution in an advective semi-arid environment with airborne multispectral imagery. World Environmental and Water Resources Congress 2009: Great Rivers. Am. Soc. Civil. Engr. 4411-4421.

Chávez, J., **T. Howell,** D. Straw, **P. Gowda**, L.Garcia, **S. Evett**, T. Ley, L. Simmons, M. Bartolo, **P. Colaizzi**, and A. Andales. 2010. Surface Aerodynamic Temperature Derived from Wind/Temperature Profile Measurements over Cotton and Alfalfa. World Environmental & Water Resources Congress, Providence, Rhode Island, 16-20 May 2010. EWRI.

Colaizzi, P. D., P. H. Gowda, T. H. Marek, and D. O. Porter. 2009. Irrigation in the Texas High Plains: A brief history and potential reductions in demand. Irrig. and Drain. 58(3): 257-274. DOI: 10.1002/ird.418.

Colaizzi, P.D., S.R. Evett, T.A. Howell, and **R.L. Baumhardt**. 2009. Comparison of grain sorghum, soybean, and cotton production under spray, LEPA, and SDI. pp. 122-139 in Proc. 21st Annual Central Plains Irrig. Conf., Colby Kansas, February 24-25, 2009. CPIA, 760 N.Thompson, Colby, Kansas.

Evett, S.R., N.T. Mazahrih, M.A. Jitan, M.H. Sawalha, **P.D. Colaizzi**, and J.E. Ayars. 2009. A weighing lysimeter for crop water use determination in the Jordan Valley, Jordan. Trans. ASABE 52(1):155-169.

Evett, S.R., and **R.C. Schwartz.** 2009. Comments on "J. Vera et al., Soil water balance trial involving capacitance and neutron probe measurements". Agric. Water Manage. 96:905–911.

Evett, S.R., R.C. Schwartz, J.A. Tolk, and T.A. Howell. 2009. Soil profile water content determination: Spatiotemporal variability of electromagnetic and neutron probe sensors in access tubes. Vadose Zone J. 8(4):926-941.

Evett, S.R., and **J.A. Tolk**. 2009. Introduction: Can water use efficiency be modeled well enough to impact crop management? Agron. J. 101(3):423–425.

Gowda, P., G.B. Senay, **T.A. Howell**, T.H. Marek. 2009. Lysimetric evaluation of simplified surface energy balance approach in the Texas High Plains. Applied Engineering in Agriculture. 25(5):665-669.

Heng, L.K., T. Hsiao, **S. Evett, T. Howell**, and Pasquale Steduto. 2009. Validating the FAO AquaCrop model for irrigated and water deficient field maize. Agron. J. 101(3):488-498

Hernandez, J.E., P.H. Gowda, D. Misra, T.H. Marek, and **T.A. Howell**. 2009. Calibrating Northern Texas High Plains groundwater model. Paper # 096270. Proceedings of the 2009 ASABE Annual International Meeting, June 21-24, 2009. Reno, NV.

Hernandez, J.E., P.H. Gowda, D. Misra, T.H. Marek, and **T.H. Howell**. 2009. Validating Northern Texas High Plains groundwater model with data from observation wells. Paper # H21C-0858. Proceedings of the 2009 AGU Fall Meeting, December 14-18, 2009. San Francisco, CA.

Biradar, C.M., **P.H. Gowda, J.E. Hernandez, T.A. Howell**, and T.H. Marek. 2009. Irrigated area mapping in the Northern High Plains of Texas using LandSat Thematic Mapper data. Paper #H21C-0855. Proceedings of the 2009 AGU Fall Meeting, December 14-18, 2009. San Francisco, CA.

Howell, T.A. 2009. Global climatic change effects on irrigation requirements for the central Great Plains. pp. 25-39 in Proc. 21st Annual Central Plains Irrig. Conf., Colby Kansas, February 24-25, 2009. CPIA, 760 N.Thompson, Colby, Kansas.

Howell, T., S. Evett, S. O'Shaughnessy, P. Colaizzi, and **P. Gowda**. 2009. Advanced irrigation engineering: Precision and precise. 10 pp. In Proc. The Dahlia Greidinger International Symposium – March 2-5, 2009, Haifa, Israel. Technion Faculty of Civil and Environmental Engineering.

Kang, S., **S.R. Evett**, C.A. Robinson, and W.A. Payne. 2009. Simulation of winter wheat evapotranspiration in Texas and Henan using three models of differing complexity. Agric. Water Manage. 96:167-178.

Kjaersgaard, J.H., **P.H. Gowda**, R.G. Allen, and **T.A. Howell**. 2009. Independent comparisons among calibration and output of energy balance components estimated by the METRIC procedure. World Environmental and Water Resources Congress 2009: Great Rivers. Am. Soc. Civil. Engr. 4362-4371.

Ko, J., G. Piccinni, T. Marek, and **T. Howell**. 2009. Determination of growth-stage-specific crop coefficients (Kc) of cotton and wheat. Agric. Water Manage. 96:1691–1697.

Meek, D.W., **T.A. Howell**, C. Phene. 2009. Concordance correlation for model performance assessment: An example with reference evapotranspiration. Agron. J.. 101(4): 1012-1018.

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Lamm, F., **T.A. Howell**, and J.P. Bordovsky. 2009. Ensuring equal opportunity sprinkler irrigation. Arab Water World 33(1):34-36.

Logsdon, S.D., T.R. Green, M. Seyfried, **S.R. Evett**, and J. Bonta. 2009. Hydra Probe and twelve-wire probe comparisons in fluids and soil cores. Soil Sci. Soc. Am. J. 74:5-12.

Meek, D.W., **T.A. Howell**, and C. Phene. 2009. Concordance correlation for model performance assessment: An example with reference evapotranspiration. Agron. J. 101(4):1012-1018.

O'Shaughnessy, S.A., and **S.R. Evett**. 2009. Using Radiation Thermometry to Assess Spatial Variation of Water Stressed Cotton. In Proc. Irrigation Association Show 2009, December 2-4, 2009, San Antonio, Texas, CD-ROM.

Schwartz, R.C., and **S.R. Evett**, M.G. Pelletier, and **J.M. Bell**. 2009. Complex permittivity model for time domain reflectometry soil water content sensing: I. Theory. Soil Sci. Soc. Am. J. 73(3):886-897.

Schwartz, R.C., S.R. Evett, and **J.M. Bell**. 2009. Complex permittivity model for time domain reflectometry soil water content sensing: II. Calibration. Soil Sci. Soc. Am. J. 73(3):898-909.

Singh, S., I. Chaubey, and **P.H. Gowda**. 2009. Application of remote sensing based tillage mapping technique to evaluate water quality impacts of tillage management decisions in Upper White River Basin. World Environmental and Water Resources Congress 2009: Great Rivers. Am. Soc. Civil. Engr. 4392-4399.

Tolk, J.A., and **S.R. Evett**. 2009. Lysimetry versus neutron moisture meter for evapotranspiration determination in four soils. Soil Sci. Soc. Am. J. 73(5):1693-1698.

Tolk, J.A., and **T.A. Howell**. 2009. Transpiration and yield relationships of grain sorghum grown in a field environment. Agron. J. 101(3):657-662.

Zalesny, R.S., **S.R. Evett**, N.F. Kandil, C. Soriano and J. Stanturf. 2009. Opportunities for woody crop production using treated wastewater in Egypt. Proc. 6th International Phytotechnology Conference, December 1-4, 2009, St. Louis, Missouri. ■

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Gowda, P.H., T.A. Howell, R. Vinukollu, P.D. Colaizzi, S. Evett and K.S. Copeland. 2009. Evaluation of Five Surface Energy Balance Approaches for Mapping ET Using Landsat TM Data Acquired During BEAREX08.

Lascano, R.J., C.H.M van Bavel, and S.R. Evett. 2009. Alfalfa Canopy Resistance from Lysimetric and Radiometric Measurements.

McKee, L., M.H. Cosh, and S. Evett. 2009. Comparison of Soil Water Content Distributions Between Irrigated and Non-Irrigated Cropland During the BEAREX08 Experiment.

Prueger, J.H., W.P. Kustas, L.E. Hipps, J.L. Chavez, S. Evett, A. French, and J. L. Hatfield. 2009. BEAREX_08 Eddy Covariance Intercomparison.

Schwartz, R.C., R.L. Baumhardt, and S.R. Evett. 2009. Tillage Effects on Soil Water Redistribution and Bare Soil Evaporation throughout a Season.

Schwartz, R.C., S.R. Evett, and J. Bell. 2009. A Complex Permittivity Model for Field Estimation of Soil Water Contents Using Time Domain Reflectometry.

Tolk, J.A., and T.A. Howell. 2009. Water use and yield of cotton grown in four Great Plains soils.

On 2-4 November 2009, Susan O'Shaughnessy attended the Irrigation Association Conference in San Diego, CA, and presented "Using Radiation Thermometry to Assess Spatial Variation of Water Stressed Cotton" by O'Shaughnessy, S.A., and S.R. Evett, Using Radiation Thermometry to Assess Spatial Variation of Water Stressed Cotton, Paper IA09-1012, Proc. Irrigation Association Technical Conference, 2009.

On November 15, 2010, Terry Howell met with a committee to plan new cooperative research with the North Plains Groundwater District for the Texas AgriLife Research North Plains Field station at Etter, TX.

On December 1, 2009, Terry Howell met with the new Texas AgriLife Research Director, Dr. Craig L. Nessler, and the Associate Director, Dr. Bill F. McCutchen, together with Dr. John Sweeten, Resident Director of the Amarillo Agricultural Research Center to tour Bushland facilities.

Susan O'Shaughness participated in the Irrigation Association Show, December 2-4, 2009, San Antonio, TX, presenting lecture on "Using Radiation Thermometry for Spatial Assessment of Water Stressed Cotton".

Steve Evett made two presentations: "Soil Water Sensors for Irrigation Scheduling: Can They Deliver a Management Allowed Depletion?" and "The Middle East Regional Irrigation Management Information Systems Project – Update", at the International Symposium on Olive Irrigation and Oil Quality, Nazareth, Israel, December 5-10, 2009.

Steve Evett attended the Middle East Regional Irrigation Management Information Systems Project workshop and presented a project update in Nazareth, Israel, December 5, 2009.

Drs. Prasanna Gowda and Jairo Hernandez attended the AGU Fall Meeting, December 14-18, 2009 in San Francisco, CA. Prasanna Gowda co-presided over two sessions, the poster session, Understanding Land-Atmosphere Interactions With Models and Observations I and Understanding Land-Atmosphere Interactions With Models and Observations II.

Abstracts from the AGU Meeting

Gowda, P.H., T.A. Howell, O. Hartogensis, S. Basu, B.R. Scanlon. 2009. Effect of Scintillometer Height on Structure Parameter of the Refractive Index of Air Measurements.

Biradar, C.M., P.H. Gowda, J.E. Hernandez, T.A. Howell, T.H. Marek, X. Xiao. 2009 Irrigated Area Mapping in The Northern High Plains of Texas Using Landsat Thematic Mapper Data.

Contreras López, S., P.H. Gowda, B.R. Scanlon, E.G. Jobbagy, D. Alcaraz-Segura, R.C. Reedy. 2009. A Satellite-based Approach to Evaluate the Impact of Land Use Change on Recharge Rates in the Southern High Plains.

Hernandez, J.E., P.H. Gowda, D. Misra, T.H. Marek, T.A.Howell. 2009. Validating Northern Texas High Plains Groundwater Model with Data from Observation Wells.

Kamble,B., A. Irmak, P.H. Gowda. 2009. Evaluation of Noah-LSM and METRIC-based Evapotranspiration Predictions with Bowen Ratio Measurements over Irrigated Corn Field.

Kersh, K.L., P.H. Gowda, S. Basu, T.A. Howell, S.O'Shaughnessy, N. Rajan, O.Z. Akasheh. 2009. Vegetation Fraction Mapping with Artificial Neural Network and High Resolution Multispectral Aerial Imagery Acquired During BEAREX07.

Rajan, N., P.H. Gowda, S.J. Maas, S. Basu, S.S. Nair. 2009. Vegetation cover mapping at multiple scales using MODIS, Landsat, RapidEye, and Aircraft imageries in the Texas High Plains.

Ruiz-Columbie, A., S. Basu, P.S.Skinner, P.H.Gowda, S. Harshan. 2009.Observational and Modeling Studies of Evening Transitional Boundary Layers.

On December 16-19, 2009, Drs. Terry Howell and N. Andy Cole along with Lynnette Lott, Beth Holt, and Sharon Parkhurst participated in the SPA Leadership Conference in Westlake, TX.

On January 7, 2010, Terry Howell represented the CPRL at the annual Amarillo Medical Center Luncheon at the Amarillo Botanical Gardens.

On January 28, 2010, Terry Howell presented an overview of CPRL research programs and recent and future planned facility projects to the Panhandle Regional Planning Commission for the Small Business Entrepreneurs meeting

February, 2-4, 2010, Drs. Terry Howell and N. Andy Cole and Lynnette Lott participated in the Brookings Executive Education training on Managing the Federal Employee Discipline and Performance Process in College Station, TX at the ARS-Southern Plains Area Office. ■

Awards & Recognitions

On August 29, 2009, Dr. Terry Howell had the pleasure of attending the WTAMU Dept. of Agricultural Sciences Recognition of Graduates of Distinction, First Choice Awards and 48th Annual Scholarship Awards ceremony at WTAMU. The ceremony emphasized the outstanding work of many WTAMU agricultural sciences students. The following CPRL employees were recognized as scholarship recipients: Stephanie Schumacher (twice), Aaron Davis, Kari Schilling, Gretchen Adams as well as to graduate student Partson Mutvumba who is advised by Steve Evett and Robert Schwartz.

Dr. Nolan Clark, long time irrigation researcher, laboratory director and head of the wind energy research program at Bushland, retired in July 2009. (below)

Soil scientist B.A. Stewart, former laboratory director at the ARS Conservation and Production Research Laboratory in Bushland, Texas and two other retired ARS scientists were inducted on September 16, 2009, into the ARS Science Hall of Fame. (pictured left to right: Drs. E.B. Knipling, B.A. Stewart, and D.R. Upchurch)

Gretchen Adams, Biological Science Aide and West Texas A&M Student, won third place for the SASES visual presentation student competition at the Tri-Society Meetings in Pittsburg, PA, November 1-5, 2009. The title of the presentation was “Soil and Water Management”.

Steve Evett and Judy Tolk were asked to be members of the Editorial Advisory Board, Agricultural Water Management, January, 2010.

Judy Tolk was asked to serve as Senior Associate Editor, Agronomy Journal, August, 2009.

Paul Unger, retired Soil Scientist, was among the distinguished indiviuals who received awards during the 2009 ASA-CSSA-SSSA Societies Annual Meeting in Pittsburgh, PA. He received the Soil Science Distingushed Service Award and continues to collaborate on projects with the Soil and Water Management Research Unit. (right)

Nolan Clark presented Terry Howell with the 30 year USDA-ARS Employment Plaque and pin. Dr. Howell was also recently recognized as a 40 year member with ASABE. (left)

Employee Spirit

Blood Drives

Regular blood drives are set up every 6 to 9 weeks for employees to give blood. A staff member from the Coffee Blood Memorial Center draws blood from Jairo Hernandez.

Student Appreciation

Former Director Nolan Clark dishes out homemade ice cream to Sharon Parkhurst (far right). Summer students gather for a picture in front of the station.

Saving Nature

Employees are always watching out for the safety of wildlife that make their home on the station. This barn owl was rescued by a licensed representative of South Plains Wildlife Rehabilitation Center in Lubbock, Texas.

Soil and Water Management Research Unit

http://www.cprl.ars.usda.gov

RESEARCH STAFF

Dr. Terry A. Howell, P.E.
Acting Laboratory Director
Research Leader (Agric. Engr.)
(806) 356-5746
terry.howell@ars.usda.gov

Dr. R. Louis Baumhardt
Research Soil Scientist
(806) 356-5766
r.louis.baumhardt@ars.usda.gov

Dr. Dave Brauer
Research Agronomist
(806)356-5769
david.brauer@ars.usda.gov

Dr. Paul D. Colaizzi
Research Agricultural Engineer
(806) 356-5763
paul.colaizzi@ars.usda.gov

Karen S. Copeland
Soil Scientist
(806) 356-5735
karen.copeland@ars.usda.gov

Dr. Steven R. Evett
Research Soil Scientist
(806) 356-5775
steve.evett@ars.usda.gov

Dr. Prasanna Gowda
Research Agricultural Engineer
(806) 356-5730
prasanna.gowda@ars.usda.gov

Dr. Wonsook Ha
Research Agricultural Engineer
(806) 356-5717
wonsook.ha@ars.usda.gov

Dr. Jairo Hernandez
Research Agricultural Engineer
(806) 356-5718
jairo.hernandez@ars.usda.gov

Dr. Susan O'Shaughnessy
Research Agricultural Engineer
(806) 356-5770
susan.oshaughnessy@ars.usda.gov

Dr. Robert C. Schwartz
Research Soil Scientist
(806) 356-5762
robert.schwartz@ars.usda.gov

Dr. Judy A. Tolk
Research Plant Physiologist
(806) 356-5736
judy.tolk@ars.usda.gov

Dr. Paul W. Unger
Collaborator (Soil Scientist)
(806) 356-5749
pwunger@suddenlink.net

Publication Contact

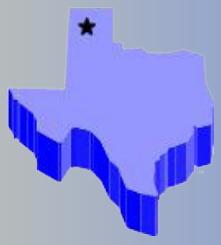
The *Wetting Front* publication is designed to foster technology transfer from our research to industry and to agricultural producers in the Southern High Plains and to improve communications with our stakeholders and partners.

All issues will be sent by email or are available on the website www.cprl.ars.usda.gov/Wetting_Front_Newsletter.htm

If you would like to receive each issue by email send your email address in an email with Subject Line: Wetting Front to nancy.davis@ars.usda.gov.

For actions or corrections to our email list, contact Ms. Nancy Davis by one of the following:

fax: (806) 356-5750
email: nancy.davis@ars.usda.gov
phone: (806) 356-5732
mail: USDA-ARS
P.O. Drawer 10
Bushland, TX 79012



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Editors: Dr. Terry A. Howell, P.E. / Nancy Davis
USDA-ARS
P.O. Drawer 10
Bushland, TX 79012-0010

Email: terry.howell@ars.usda.gov / nancy.davis@ars.usda.gov
Phone: (806)356-5746 / (806)356-5732
Fax: (806)356-5750
Shipping: 2300 Experiment Station Road

United States Department of Agriculture
Agricultural Research Service

USDA-ARS
P.O. Drawer 10
Bushland, TX 79012-0010