

# Jan M.H. Hendrickx, Ph.D., Ir.

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## Professional Preparation

<b>B.S. Civil Engineering and Irrigation</b>	Wageningen University	1972
<b>M.S. Civil Engineering and Irrigation</b>	Wageningen University	1975
<b>Ph.D. Soil Physics (minor in Statistics)</b>	New Mexico State University	1984
<b>Postdoctoral Agricultural Engineering</b>	Texas A&M University	1985

## Professional Experience

*New Mexico Institute of Mining and Technology, Dept. of Earth and Environmental Science*

2016 to present Professor Emeritus of Hydrology

Large scale evapotranspiration mapping for statewide water assessment in New Mexico. Water and energy balance of steep tropical hill slopes in Panama Canal Watershed. Machine learning for downscaling Landsat derived evapotranspiration and root zone soil moisture maps.

1990 to 2015 Professor of Hydrology

Teaching graduate courses in hydrology, remote sensing, environmental physics, soil physics and micrometeorology. Active research program to investigate physical processes in the vadose zone and the near surface atmospheric boundary layer with a focus on quantitative hydrology remote sensing at different scales. Physics of sensor-soil-IED systems to enhance detection of Improvised Explosive Devices in field soils.

*Centrum for Development Research, Rheinische Friedrich-Wilhelm University Bonn, Germany*

2003 to 2014 Senior Fellow of Ecology and Natural Resource Management

Soil moisture and evapotranspiration from remote sensing in the Volta Basin (Ghana, Burkina Faso). Water and salt management in Uzbekistan.

*International Institute for Land Reclamation and Improvement, Wageningen, The Netherlands*

1988 to 1990 Irrigation & Drainage Engineer and Research Leader

Stationed in Lahore, Pakistan at the Water and Power Development Authority. Simulation and evaluation of water and salt balances in arid regions. Study of drainage design criteria. Management of water quantity and quality in irrigated areas. Managing field and laboratory research.

*The Netherlands Soil Survey Institute (Stiboka), Wageningen, The Netherlands*

1985 to 1988 Soil Hydrologist and Head of Department of Soil Physics & Hydrology

Study of solute movement in field soils, effects of unstable wetting fronts on transport mechanism. Simulation and evaluation of regional soil moisture regimes. Responsible for research program development as well as field research and laboratory of soil physics and hydrology.

*Texas A&M University, Department of Agricultural Engineering, College Station, Texas*

1984 - 1985 Research Agricultural Engineer and PostDoc

Simulation of infiltration in irrigated and dryland agricultural fields with finite element model. Research on soil moisture variability.

*New Mexico State University, Dept. of Agronomy and Horticulture, Las Cruces, New Mexico*

1981 - 1984 Research Assistant of Soil Physics

Water use of trickle irrigated chile peppers. Spatial variability of soil water tension and water content. Water balance in Chihuahuan desert.

*Wageningen University, Department of Civil Engineering and Irrigation, The Netherlands*

1979 to 1981      Irrigation & Drainage Engineer and Research Leader

Stationed in Nioni, Mali at the Office du Niger. Determination of water requirements for rice and sugarcane. Evaluation of furrow irrigation systems for sugarcane. Development of drainage design criteria for irrigated rice fields.

*Agrar und Hydrotechnik GmbH, Essen, Germany*

1978 - 1979      Irrigation and Drainage Engineer

Consulting engineer. Different tasks: design of irrigation and drainage schemes. Use of aerial photographs. Engineering field work in Tanzania.

*Program for the Application of Appropriate Technology, Campina Grande, Paraiba, Brazil*

1976 - 1978      Irrigation Engineer and OXFAM Volunteer

Design of inexpensive trickle irrigation systems with wind powered water supply. Design criteria for rainwater harvesting cisterns for semi-arid northeastern Brazil.

*Wageningen University, Department of Civil Engineering and Irrigation, The Netherlands*

1975 - 1976      Instructor

Teaching and evaluation of project based courses in irrigation engineering. Research on drip irrigation.

*Institute for Land and Water Management, Wageningen, The Netherlands*

1973      Research Assistant

Investigation of compaction of sand soil during wetting.

*Agricultural Experiment Station, Paramaribo, Suriname (South America)*

1972      Research Assistant

Investigation of the effect of soil compaction on yield of soja beans. Design of experimental sprinkler systems with high uniformity of water application.

### **Awards and Honors**

- 2017    Recipient of the William R. Boggess Award for the most outstanding paper "Benchmarking Optical/Thermal Satellite Imagery for Estimating Evapotranspiration and Soil Moisture in Decision Support Tools" published in the Journal of the American Water Resources Association during 2016
- 2002    Fellow of the Soil Science Society of America
- 2000    Fullbright Scholar, Universidad Nacional de Colombia at Medellín

### **Memberships**

American Geophysical Union  
Soil Science Society of America  
Royal Society of Agricultural Science of The Netherlands

### **Research Interests**

The process of water and solutes movement through the vadose zone and the application of computer models to this process. Groundwater recharge and contamination in deserts, irrigated lands, and metropolitan areas. The application of remote sensing for determination of actual evapotranspiration, root zone soil moisture and soil water storage capacity. Irrigation and

drainage for salinity management. The impact of spatial and temporal variability of soil physical properties on sensors for detection of IED's (improvised explosive devices). The occurrence and effects of unstable wetting fronts. Use of electromagnetic induction methods for environmental surveys and non-invasive soil water content determination. Energy balance measurements using scintillometry. Python scripts development for quantifying statewide evapotranspiration in New Mexico. Machine learning for downscaling Landsat derived evapotranspiration and root zone soil moisture maps. Using radar images for mapping of evapotranspiration in the cloudy humid tropics.

### **Research Career**

Dr. Hendrickx has been PI/Co-PI on research projects funded by NSF, NASA, USDA, DOD, DOE, NGA as well as state agencies. He has authored or coauthored over 150+ refereed papers and book chapters. He is a google scholar: citations >6000, h-index 41, i10-index 94. He has conducted short term assignments in the Volta Basin (Ghana, Burkina Faso) for the University of Bonn, Karnataka (India) for WorldBank, tropical areas of Australia-Suriname-Honduras-Panama as a member of a US Army science panel; he has taught vadose zone hydrology workshops in Spanish for professionals in Colombia, Mexico, Venezuela and Bolivia. He was a volunteer for OXFAM in the Northeast of Brazil (1978-1979) adapting applied technology concepts to irrigated horticulture. He was an intern at the Suriname Agricultural Experiment Station in 1972. He is fluent in English, Spanish and Dutch; working knowledge of French, German and Portuguese. He has investigated the water requirements of rice and sugarcane in the Office du Niger (Mali) and of drip irrigated chile peppers in New Mexico. In Pakistan he conducted research for the optimization of drainage design criteria in irrigated lands to maximize yield and minimize salinity damage to rice and wheat. Since 2005 he has validated and used the METRIC (Mapping Evapotranspiration at high Resolution with Internalized Calibration) algorithms not only within the USA but also in West-Africa, Morocco, Panama, and Afghanistan. Currently, a version of METRIC operates on the Google Earth Engine system; it's called EEFLUX (Earth Engine Evapotranspiration Flux).

### **LANGUAGES**

<b>Speaking:</b>	Dutch, English, Spanish, German, French, Portuguese
<b>Reading:</b>	Dutch, English, Spanish, French, German, Portuguese
<b>Writing:</b>	Dutch, English, Spanish

### **COMPUTER SCIENCE**

<b>Languages:</b>	Python (NumPy, PyTorch, Pandas), ERDAS Imagine, QGIS, Matlab, SAS, FORTRAN
<b>Models:</b>	HYDRUS 2D/3D for Windows is a software package for simulating water, heat, and solute movement in two- and three-dimensional variably saturated soils.

## **Relevant Recent Publications**

- Myint, S., J.M.H. Hendrickx et al. (2020), Adaptive Crop Management Under Climate Uncertainty: Changing the Game for Sustainable Water Use, Agric. Water Manage., Revision Submitted.
- Litt, G.F., F.L. Ogden, A. Mojica, J. M.H. Hendrickx et al. (2019), Land cover effects on soil Infiltration capacity measured using plot scale rainfall simulation in steep tropical lowlands of Central Panama, Hydrologic Processes, <https://doi.org/10.1002/hyp.13605>.
- Hendrickx, J. M. H., et al. (2016), Benchmarking optical/thermal satellite imagery for estimating evapotranspiration and soil moisture in decision support tools Journal American Water Resources Association, 52(1), 89-119.
- Hong, S.-h., K. Lenth, R. Aumer, B. Borchers, and J. M. Hendrickx (2016), Spatial variability of SEBAL estimated root-zone soil moisture across scales, International Journal of Remote Sensing, 37(20), 4838-4853.
- Engle, E. M., J. B. J. Harrison, J. M. H. Hendrickx, and B. Borchers (2014), Remote sensing for soil map unit boundary detection, in Military Geosciences in the 21st Century. Reviews in Engineering Geology Series, edited by R. S. Harmon and E. V. MacDonald, pp. 119-130, Geological Society of America.
- Wohl, E., ..., J.M.H. Hendrickx et al. (2012), The hydrology of the humid tropics, Nature Clim. Change, 2, 655–662, doi:10.1038/nclimate1556.
- Allen, R. G., A. Irmak, R. Trezza, J. M. H. Hendrickx, W. G. M. Bastiaanssen, and J. Kjaersgaard (2011), Satellite-based ET estimation in agriculture using SEBAL and METRIC, Hydrologic Processes, 25, 4011–4027.
- Hendrickx, J. M. H., J. B. J. Harrison, B. Borchers, J. R. Kelley, S. Howington, and J. Ballard (2011), High-resolution soil moisture mapping in Afghanistan, Proc. International Society for Optical Engineering, SPIE, 8017, 801710; doi:10.1117/1.801117/801712.887255.
- Sorooshian, S., ..., J.M.H. Hendrickx et al. (2011), Advanced Concepts on Remote Sensing of Precipitation at Multiple Scales, Bulletin of the American Meteorological Society, 92(10), 1353-1357, doi:10.1175/2011bams3158.1.
- Hong, S.-H., J. M. H. Hendrickx, and B. Borchers (2011), Down-scaling of SEBAL derived evapotranspiration maps from MODIS (250 m) to Landsat (30 m) scales, International Journal of Remote Sensing, 32(21), 6457-6477.
- Kleissl, J., S.-h. Hong, and J. M. H. Hendrickx (2009), New Mexico scintillometer network. Supporting remote sensing and hydrologic and meteorological models, Bulletin American Meteorological Society, 90(2), 207-218, DOI:10.1175/2008BAMS2480.1171.
- Hendrickx, J. M. H., B. Rabus, D. C. Romero, H. Wehn, J. B. J. Harrison, S.-h. Hong, B. Borchers, and J. Slater (2009), Preliminary validation of Radarsat2 surface soil moisture estimates, Proc. International Society for Optical Engineering, SPIE, 7303, 730310.
- Hong, S.-h., J. M. H. Hendrickx, and B. Borchers (2009), Up-scaling of SEBAL derived evapotranspiration maps from Landsat (30 m) to MODIS (250 m) scale, J. Hydrol., 370, 122-138; doi:10.1016/j.jhydrol.2009.1003.1002
- Compaoré, H., J. M. H. Hendrickx, S.-h. Hong, J. Friesen, N. C. van de Giesen, C. Rodgers, J. Szarzynski, and P. L. G. Vlek (2008), Evaporation mapping at two scales using optical imagery in the White Volta Basin, Upper East Ghana. Physics and Chemistry of the Earth, Parts A/B/C, 33, 127-140, doi:10.1016/j.pce.2007.1004.1021.
- Friesen, J., C. Rodgers, P. G. Oguntunde, J. M. H. Hendrickx, and N. v. d. Giesen (2008), Hydrotope-based protocol to determine average soil moisture over large areas for satellite calibration and validation - With results from an observation campaign in the Volta Basin, West Africa, IEEE Transactions on Geoscience and Remote Sensing, 46(7), 1995 - 2004 DOI 10.1109/TGRS.2008.916638.
- Hendrickx, J. M. H., A. Molina, D. Diaz, M. Grasmueck, H. A. Moreno, and R. D. Hernández (2008), Humanitarian IED clearance in Colombia, Proc. International Society for Optical Engineering, SPIE, 6953, 69530C DOI: 10.1117/69512.782303.
- Hendrickx, J. M. H., H. Xie, J. B. J. Harrison, B. Borchers, and J. Simunek (2008), Global prediction of thermal soil regimes, Proc. International Society for Optical Engineering, SPIE, 6953, 69530Y DOI: 10.1117/69512.782251.

For a full list of my publications see

<https://scholar.google.com/citations?user=n6eB9w8AAAAJ&hl=en>

## Consulting Resume of JAN M.H. HENDRICKX, Ph.D., Ir.

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SoilHydrology Associates LLC is a scientific advisory partnership that transfers advances in academic soil hydrology research to practitioners who need novel technologies for improved management of environmental and hydrological resources. We help by putting novel soil hydrology technologies into operation and by organizing technology transfer workshops. Current projects focus on: 1. Mapping temporal and spatial distributions of regional evapotranspiration and root zone water content using optical satellite imagery; 2. Predicting the fate of produced waters using non-invasive geophysical field measurements and vadose zone modeling; 3. Participating in science panels to advise on a range of soil hydrology and vadose zone issues; 4. Using simple neural networks as a tool to quantify non-linear relationships useful for soil hydrology applications. Our associates are mostly university professors selected on a project by project basis.

### **SERVICES PROVIDED SINCE 1993 BY “SOIL HYDROLOGY ASSOCIATES LLC” (2006 – PRESENT) AND ‘ENVIRONMENTAL HYDROLOGY APPLICATIONS (1993 – 2005)’.**

2019 - present	<u>Preparation of Appeal to a Replacement Water Assessment by Antelope Valley CA Watermaster</u> Project Description: Quality check and correction of Google Earth Engine EEFLUX actual evapotranspiration data. Quantify the annual 2018 evapotranspiration on 80 acres of formerly irrigated land. Prepare report with evidence that farmer did NOT apply irrigation water to this land in 2018. <u>Client:</u> Farmer in Antelope Valley, California
2018 - present	<u>Preparation of Expert Testimony for Produced Water Contamination Claim of Landowner</u> Project Description: Examine geophysical surveys ordered by landowner and evaluate the quality of the measurements. Take soil samples. Run electromagnetic induction forward and inverse models to determine the fate of produced waters at the site near Carlsbad, New Mexico. <u>Client:</u> Advance Energy Partners, LLC, Houston, Texas
2018 - present	<u>Interpretation of geophysical measurements with the EM38 electromagnetic induction meter</u> Project Description: Assist field technicians with the interpretation of EM38 measurements for the delineation of the horizontal and vertical extend of contamination by produced waters in the Permian Basin in New Mexico. <u>Client:</u> R.T. HICKS CONSULTANTS, Ltd., Albuquerque, New Mexico

2019	<p><u>Preparation of Expert Testimony for the United States District Court for the District of New Mexico</u></p> <p>Project Description: Use satellite remote sensing images and soil observations for investigation of a fire that the defendant contends to have occurred at an open-air haystack lot on Armstrong Farms near Dell City TX in August 2017. Review the information provided by defendant during his depositions. A difficult assignment because “Absence of evidence is not evidence of absence”. In the end I could proof that there never was hay nor a hay fire at Armstrong Farms.</p> <p><u>Client:</u> Marrs Griebel Law, Ltd., Albuquerque, New Mexico</p>
2018 - 2019	<p><u>Sampling of Representative American Soils</u></p> <p>Project Description: Take samples of representative American soils in New England, the Carolinas, and the Southwest in support of the project “Integrated multimodal Sensor Technology for Rapid, In-situ Chemical Analysis of Soil and Materials of Military Interest Under Ambient Conditions in the Field.”</p> <p><u>Client:</u> US Army Engineering Research and Development Center, Cold Regions Research and Engineering Laboratory, New Hampshire</p>
2018	<p><u>Quantify Evaporation of the Tailing Facility of Robinson Nevada Mining Company during 2015 - 2018</u></p> <p>Project Description: Convert Landsat imagery into evaporation estimates during the period 2016 through 2018 for estimation of total evaporation volume from the tailings storage facility.</p> <p><u>Client:</u> Geosystems Analysis, Inc., Tucson, AZ</p>
2015 – 2018	<p><u>Assessment of Hydrologic Soil Properties in the Panama Canal Watershed, Panama</u></p> <p>Project Description: Assess the hydrologic properties of the tropical soils and underlying geological layers in the Panama Canal Watershed using field observations in soil pits, laboratory analyses and data from the literature. The overall goal is to better understand how tropical forest soils enhance the sponge effect and how different land uses (full forest cover, secondary forest and pasture) change the sponge effect through changes in soil hydraulic properties. This project is a sub-award to a NSF research project.</p> <p><u>Client:</u> University of Wyoming, Laramie, WY</p>
2015	<p><u>Quantify Evaporation of the Tailing Facility of Robinson Nevada Mining Company during 1996 - 2015</u></p> <p>Project Description: Convert Landsat imagery into evaporation estimates during the period 1996 through 2015 for estimation of total evaporation volume from the tailings storage facility.</p> <p><u>Client:</u> Geosystems Analysis, Inc., Tucson, AZ</p>

2012 – 2016	<p><u>Quantify the Seasonal Evapotranspiration of Irrigated Lands in the Green River Basin of Wyoming</u></p> <p><u>Project Description:</u> Use the remote sensing algorithm Mapping EvapoTranspiration at High Resolution with Internal Calibration (METRIC) for the quantification of annual evapotranspiration in the Green River Basin of Wyoming.</p> <p><u>Client:</u> Office of the State Engineer of Wyoming</p>
2012 – 2014	<p><u>Preparation of Expert Testimony for Superior Court of the state of California for the County of Los Angeles</u></p> <p><u>Project Description:</u> Quantify urban return flow for Antelope Valley; prepare expert testimony. Present my expert opinion in a hearing.</p> <p><u>Client:</u> Brownstein   Hyatt   Farber   Schreck, Santa Barbara, CA.</p>
2011	<p><u>Evaluation of Current and Future Hydrologic Monitoring in the State of Karnataka, India</u></p> <p><u>Project Description:</u> Evaluate hydrologic monitoring (precipitation, ET, runoff, sediment transport, soil moisture storage) and advice on improvements for future hydrologic monitoring in the semi-arid areas of Karnataka underlain by hard rock aquifers.</p> <p><u>Client:</u> World Bank, Washington DC.</p>
2009 – 2011	<p><u>Preparation of Expert Testimony for Superior Court of the state of California for the County of Los Angeles</u></p> <p><u>Project Description:</u> Combine METRIC ET and root zone water content distributions with a distributed hydrologic model for evaluation of net infiltration in the San Gabriel and Tehachapi Mountains; prepare expert testimony. Present my expert opinion in hearings and trial.</p> <p><u>Client:</u> Brownstein   Hyatt   Farber   Schreck, Santa Barbara, CA.</p>
2011	<p><u>Evaluation of METRIC for the Southern High Plains</u></p> <p><u>Project Description:</u> Evaluate how METRIC can be used for the assessment of ground water recharge on the High Plains of Texas.</p> <p><u>Client:</u> Bureau of Economic Geology, University of Texas, TX.</p>
2010	<p><u>Mapping of Evapotranspiration in the Clover Basin, Nevada.</u></p> <p><u>Project Description:</u> Use METRIC for the assessment of evapotranspiration in the Clover Basin of Nevada.</p> <p><u>Client:</u> Daniel B. Stephens &amp; Associates, Inc., Albuquerque, NM</p>
2009 - 2010	<p><u>Mapping of evapotranspiration in the Salt Basin, New Mexico</u></p> <p><u>Project Description:</u> Use METRIC for the assessment of evapotranspiration from irrigated fields and playas in the Salt Basin of New Mexico.</p> <p><u>Client:</u> INTERA Incorporated, Albuquerque, NM</p>

2009	<p><u>Evaluation of the Guidelines for Produced Water Disposals in Wyoming</u>  <u>Project Description:</u> Evaluate the 2009 guidelines for produced water disposal from coalbed methane gas wells in Wyoming.  <u>Client:</u> Wyoming Department of Environmental Quality, Cheyenne, WY.</p>
2009	<p><u>Mapping of evapotranspiration in the Tadla, Doukkala, and Haouz ORMVA (Morocco) using satellite images.</u>  <u>Project Description:</u> Use METRIC to make assessment of seasonal ET over three irrigation projects in Morocco.  <u>Client:</u> Riverside Technology, Inc., Fort Collins, CO.</p>
2008	<p><u>Collaborative Research Planning Mission to the Anton de Kom University of Suriname, Paramaribo, Suriname</u>  <u>Project Description:</u> Preparation of a research proposal for strengthening the research infrastructure at the Anton de Kom University of Suriname.  <u>Client:</u> US Army Yuma Proving Grounds, Yuma, AZ.</p>
2008-2009	<p><u>SEBAL/METRIC Training to the Wyoming GIS Center</u>  <u>Project Description:</u> Train personnel of the Wyoming GIS Center in the use of SEBAL and METRIC in the Green River Basin.  <u>Client:</u> University of Wyoming, Laramie, WY.</p>
2008	<p><u>SEBAL/METRIC Training to the Center for Development Research</u>  <u>Project Description:</u> Train personnel of the Center for Development Research in the use of SEBAL and METRIC in the Volta Basin (West Africa).  <u>Client:</u> University of Bonn, Germany.</p>
2007	<p><u>A Technical Analysis of Sites in Honduras and Panama For Tropical Testing of Army Materiel, Equipment and Systems</u>  <u>Project Description:</u> Soil hydrology member of a U.S. Army science panel to develop a suite of sites to support its tropical testing mission.  <u>Client:</u> U.S. Army Research Office, Research Triangle Park, NC.</p>
2007	<p><u>Independent Review of Simulation of Net Infiltration for Present-Day and Potential Future Climates at the Yucca Mountain Project</u>  <u>Project Description:</u> Member of a science panel to provide an independent expert review of the infiltration model and prediction results for net infiltration of water into the unsaturated zone at Yucca Mountain.  <u>Client:</u> U.S. Department of Energy, Las Vegas, Nevada</p>
2006	<p><u>Mapping of Actual Evapotranspiration in Ghana, West Africa</u>  <u>Project Description:</u> Use the Surface Energy Balance Algorithms for Land (SEBAL<sup>NM</sup>) to map regional distributions of actual evapotranspiration in the Volta Basin at the start and at the end of the dry season using Landsat and MODIS images.  <u>Client:</u> University of Bonn, Bonn, Germany</p>

2006	<p><u>Chloride Mass Balance Method for Prediction of Ground Water Recharge in Southeast New Mexico</u></p> <p><u>Project Description:</u> Use of chloride measurements in soil samples from 30 m deep drillings for determination of ground water recharge rates in the oilfields of southeastern New Mexico.</p> <p><u>Client:</u> R.T. Hicks Consulting, Ltd., Albuquerque, New Mexico</p>
2005	<p><u>Evaluation of Vadose Zone Treatment Technologies to Immobilize Technetium-99</u></p> <p><u>Project Description:</u> Member of scientific panel to review treatment technologies for immobilization of high level radioactive Technetium-99 in the vadose zone.</p> <p><u>Client:</u> U.S. Department of Energy, Hanford Site, Richland, Washington</p>
2005	<p><u>Simulation of Optimal Remediation Strategy at the B.C. Dickinson A-1 Former Tank Battery Site</u></p> <p><u>Project Description:</u> Field sampling and simulations with model HYDRUS2D for the development of an optimal restoration strategy for the site in order to minimize risk for ground water contamination with chloride and BTEX.</p> <p><u>Client:</u> Whole Earth Environmental, Inc., Houston, Texas</p>
2005	<p><u>Modeling Study of Produced Water Release Scenarios</u></p> <p><u>Project Description:</u> Computer simulation study with model HYDRUS1D to provide a scientific basis for operators, regulators and landowners to determine if assessment or remediation of produced water releases will provide a meaningful environmental benefit. [API Publication Number 4734, January 2005].</p> <p><u>Client:</u> Regulatory Analysis and Scientific Affairs Department, American Petroleum Institute, Washington, D.C.</p>
2004	<p><u>Simulation of Remediation Strategies for the January 2004 Brine Release at Eidson Station</u></p> <p><u>Project Description:</u> Computer simulations with HYDRUS2D for evaluation of different remediation scenarios to optimize its final remediation plan.</p> <p><u>Client:</u> Whole Earth Environmental, Inc., Houston, Texas</p>
2003	<p><u>Regional Distribution of Soil Thermal Properties and Soil Temperature Parameters in East Africa and Asia</u></p> <p><u>Project Description:</u> Regional distribution of soil thermal conductivity, soil volumetric heat capacity, and soil thermal diffusivity at different soil field soil moisture conditions. Pedotransfer functions have been used to derive soil thermal properties from the FAO Digital World Soil Map and the WISE soil data base. Fifty maps of the region have been prepared with thermal properties of the top soil and sub soil under five different field soil moisture</p>

	<p>conditions. Model HYDRUS2D is used to analyze the effect of the depth and the strength of buried heat sources on maximum soil temperatures around the heat source.</p> <p><u>Client:</u> HARRIS CORPORATION, Government Communications Systems Division (GCSD), Palm Bay, Florida</p>
2003	<p><u>Validation of SEBAL<sup>NM</sup> for Mapping Actual Evapotranspiration in the Owens River Valley</u></p> <p><u>Project Description:</u> The Surface Energy Balance Algorithms for Land (SEBAL<sup>NM</sup>) have been validated by comparison with ground measurements of evapotranspiration in the Owens Valley. SEBAL<sup>NM</sup> is used for the preparation of maps of regional evapotranspiration that inform water resource managers about water losses.</p> <p><u>Client:</u> Inyo County Water Department, Bishop, California</p>
2003	<p><u>Electromagnetic induction for delineation of brine affected soil volumes</u></p> <p><u>Project Description:</u> Develop field procedures for the use of electromagnetic induction measurements for determination of soil volume affected by brine contamination after leaks in pipes or operation facilities.</p> <p><u>Client:</u> Rice Operating Company, Hobbs, New Mexico</p>
2003	<p><u>Soil Salinity Survey of the Zuni River Corridor</u></p> <p><u>Project Description:</u> Soil salinity survey and soil moisture sampling to locate optimal sites for Saltcedar removal and revegetation with Cottonwoods along the Zuni River.</p> <p><u>Client:</u> Fish and Wildlife Department, Riparian Restoration Project, Zuni, New Mexico</p>
2002	<p><u>Verification of Model HYDRUS1D for Prediction of Chloride Fate after Brine Releases in the Region around Hobbs, New Mexico</u></p> <p><u>Project Description:</u> Use field data obtained by Rice Operating Company for the validation of model HYDRUS1 for the prediction of chloride movement after brine leaks and for the evaluation of risk for groundwater contamination.</p> <p><u>Client:</u> Rice Operating Company, Hobbs, New Mexico</p>
2002	<p><u>Electromagnetic Induction Soil Survey for Albuquerque Biological Park Wetland Restoration Project</u></p> <p><u>Project Description:</u> Salinity survey and analysis of revegetation potential. Evaluation of future salinization risk using the computer model HYDRUS.</p> <p><u>Client:</u> US Army Corps of Engineers, Albuquerque District, New Mexico</p>
2001	<p><u>Soil Salinity in the Travis Harris Drip Irrigation Project</u></p> <p><u>Project Description:</u> Monitor soil salinity on experimental drip irrigated field to show farmers that the efficient drip irrigation method does not increase soil salinity.</p> <p><u>Client:</u> Soil &amp; Water Conservation District, Socorro, New Mexico</p>

2000	<p><u>The Santa Ana Floodplain Bosque Restoration Project</u>  <u>Project Description:</u> Soil salinity survey using electromagnetic induction. Soil survey, sampling, and measurement of hydraulic soil properties. Determination of future risk for soil salinization using model HYDRUS1D. Soil improvement plan to reduce salinity and alkalinity.  <u>Client:</u> Department of Natural Resources, Pueblo of Santa Ana, New Mexico</p>
1999	<p><u>Water Quality Changes along the Mesquite/East Drain</u>  <u>Project Description:</u> Water quality survey during the low flow season in the Mesquite/East Drain. The measurements along the Mesquite/East Drain demonstrate two important features of salinity dynamics: i. The locations of water quality deterioration along the drain during the low flow season appear to be consistent from one year to another; ii. The water quality changes are strongly correlated with the salinity of the soil-aquifer system measured with the electrical apparent ground conductivity using electromagnetic induction. Our novel approach of simultaneous water quality measurements in the drain and apparent electrical conductivity measurements of the soil-aquifer system detects in a cost effective manner salt sources in the Mesilla Valley.  <u>Client:</u> El Paso Field Division, U.S. Bureau of Reclamation, El Paso, Texas</p>
1998	<p><u>Electromagnetic Induction Survey at the Yucca Mountain High-Level Radioactive Waste Depository</u>  <u>Project Description:</u> Conduct an electromagnetic induction survey to characterize subsurface water flow paths originating from a infiltration experiment on the mountain.  <u>Client:</u> U.S. Geologic Survey, Las Vegas, Nevada</p>
1997	<p><u>Water Quality Protection for El Paso County Water Improvement District No. 1</u>  <u>Project Description:</u> Evaluation of salt sources that affect water quality in the Rio Grande at El Paso. Development of a water quality protection plan for the District.  <u>Client:</u> El Paso County Water Improvement District No. 1, El Paso, Texas</p>
1996	<p><u>Salinity Survey of Bernardo Waterfowl Management Area</u>  <u>Project Description:</u> Salinity survey and analysis of revegetation potential in the Bernardo Waterfowl Area.  <u>Client:</u> New Mexico Game and Fish, Bernardo, New Mexico</p>
1995	<p><u>Electromagnetic Induction Survey at the Socorro Mission near El Paso, Texas</u>  <u>Project Description:</u> Detection of old graves at the historical Socorro Mission. Several anomalies were detected but none were old graves.  <u>Client:</u> Office of Contract Archeology, University of New Mexico, Albuquerque, New Mexico</p>

1995	<u>Electromagnetic Induction Survey for Detection of Floating Gasoline</u> <u>Project Description:</u> Evaluate potential of electromagnetic induction for detection of floating gasoline in urban environment. Electromagnetic induction measurements clearly delineate subsurface gasoline distribution at ESSO Station in Downtown Bogota. <u>Client:</u> HIDROGEOCOL Ltda., Bogota, Colombia
1994	<u>Salinity Surveys for Revegetation in the Pueblo of Laguna</u> <u>Project Description:</u> Salinity survey and analysis of revegetation potential in the Pueblo of Laguna. <u>Client:</u> Pueblo of Laguna, Laguna, New Mexico
1994	<u>Salinity Surveys for Revegetation in the Albuquerque Bosque using Electromagnetic Induction</u> <u>Project Description:</u> Salinity survey and analysis of revegetation potential in the Bosque along the Rio Grande. <u>Client:</u> US Army Corps of Engineers, Albuquerque District, New Mexico
1994	<u>Electromagnetic Induction for Non-Intrusive Monitoring of Surface Barriers for Radioactive Waste</u> <u>Project Description:</u> Evaluation of electromagnetic induction measurements for non-intrusive monitoring of surface barriers for radioactive waste materials. The electromagnetic induction technique is suitable for non-intrusive monitoring of surface barriers for radioactive waste in order to detect large increases of water content in the barrier and the occurrence of cracks, cavities or other irregularities that may weaken the barrier. <u>Client:</u> Battelle Pacific Northwest Laboratories, Richland, Washington
1993	<u>Water and nitrogen management plan for DeRuyter's Dairy</u> <u>Project Description:</u> Preparation of management plant for use of dairy waste water for irrigation while minimizing nitrate contamination of shallow aquifer. <u>Client:</u> DeRuyter's Dairy, Mesquite, New Mexico
1993	<u>Salinity Surveys on Mine Spoils at the Navajo Coal Mine using Electromagnetic Induction</u> <u>Project Description:</u> Evaluation of electromagnetic induction measurements on mine spoils. Electromagnetic induction has great potential for inexpensive salinity surveys on mine spoils and will considerably reduce expensive field sampling. <u>Client:</u> Buchanan Environmental Consulting, Farmington, New Mexico
1993	<u>Selection of Tree Planting Sites using Electromagnetic Induction</u> <u>Project Description:</u> Use electromagnetic induction and visual observations to select optimal salt free tree planting sites along freeway I-25. <u>Client:</u> City of Socorro, New Mexico

