Water Resources Research Center
Annual Technical Report
FY 2003

Introduction

The Florida Water Resources Research Center (WRRC) was re-established as a separate entity from the combined Center for Wetlands and Water Resources Research in 1995. Historically, since 1964, the WRRC as a separate or combined center has been a university-wide focus for water-resources research and has served as the Water Resources Center for the state of Florida. The mission of the WRRC is to serve as a center of expertise in the water resources field, assist public and private interests in the conservation, development, and use of water resources, provide opportunities for professional training, assist local, state, regional, and federal agencies in planning and regulation, and communicate research findings to interested users. The WRRC administers funding received from the federal Water Resources Research Act of 1964 and coordinates water-resources research and technology transfer as authorized by the funding, acts as liaison for Florida Agencies and water management districts, promotes water-resources research by seeking external support, and seeks to enhance the state and national image of the University of Florida (UF) as a focal point for water resources research. The WRRC is funded in party by Section 104 of Public Law 98-42 and Public Law 104-99, which are administered by the U.S. Geological Survey, Department of the Interior. Additional funding and support are provided by UF and research sponsors that include state agencies such as the water management districts.

Research Program

During FY 2003, the Florida Water Resources Research Center (WRRC) supported projects that evaluated water use and nutrient leaching with high frequency irrigation as a best management practice and that characterized the spatial distribution and connectivity of wetlands in the Fisheating Creek basin in south Florida. Also, the WRRC co-sponsored an international conference in Orlando that addressed fundamental concerns of waste-contaminant applications to soils.

Evaluation of Water Use and Nutrient Leaching with High Frequency Irrigation for Use in Best Management Practices

Basic Information

Title:	Evaluation of Water Use and Nutrient Leaching with High Frequency Irrigation for Use in Best Management Practices
Project Number:	2003FL38B
Start Date:	3/1/2003
End Date:	2/29/2004
Funding Source:	104B
Congressional District:	6th
Research Category:	Not Applicable
Focus Category:	Water Quantity, Nitrate Contamination, Irrigation
Descriptors:	
Principal Investigators:	Michael Dukes

Publication

Title: Evaluation of Water Use and Nutrient Leaching Under High Frequency Irrigation for Use in Best Management Practices

Focus Categories: WQN, WQL, IG

Keywords: Water Use Efficiency, Irrigation Management, Agriculture, Nutrients, Fertilizers, Groundwater Quality, Leaching, Nitrogen, Percolation, Solute Transport, Water Quality

Duration: 03/01/2003 to 02/29/2003 (no-cost extension submitted to continue through 2/2005)

Principal investigators: Michael D. Dukes and Eric H. Simonne, University of Florida, Gainesville, FL

Congressional District: 6

Statement of critical regional water problems and research objectives:

As a result of increased competition among industrial, residential, commercial, and agricultural water users throughout Florida, much of the state will not be able to meet projected water needs in the future. Methods to optimize current uses of water including agricultural irrigation need to be developed. In addition, nitrate levels in the ground water and surface water of the Suwannee River basin have been increasing. Biological growth in the Suwannee River is limited by nitrogen; therefore, excess amounts of this nutrient input into the system results in increased growth of algae and other organisms. Much of the nitrate is believed to be a result of intense agricultural production with vegetable production being a major agricultural component of the region. The objective of this project is to assess the performance of soil moisture based drip irrigation under plasticulture on green bell pepper at minimizing irrigation water use and movement of nitrogen below the crop root zone. Soil sampling and injection of a water soluble dye will enable quantification of nutrient movement within and below the root zone and demonstrate to producers and other interested parties the movement of water within and below the crop root zone. The hypothesis is that high frequency small irrigation events will minimize irrigation water use and nitrogen leaching compared to typical practices while maintaining economical yields. There is a balance between maximizing crop yield and minimizing environmental impact. Comparisons will be made between maximum yield and minimum environmental impact.

Methods, procedures, and facilities

The experiment in 2003 was located in the Suwannee Basin at the NFREC-SV near Live Oak, FL. The experimental design consisted of four treatments replicated four times in a randomized complete block design. The bell pepper crop was fertilized according to Institute of Food and Agricultural Sciences (IFAS) recommendations. This consisted of application of nutrients based on soil test results with 25% of seasonal nitrogen applied as a granular pre-plant and the remaining 75% injected once each week at concentrations according to crop stage of growth. Treatments were established as follows: A1, automatically controlled irrigation events based on a soil moisture sensor with an integrated valve and controller (Model Flori 1, Netafim USA, Fresno, CA) set at a low soil moisture content (controller setting of “3”, “0” being dry and “10” being wet); A2, automatically controlled medium soil moisture content (controller setting of “6”); A3, automatically controlled high soil moisture content (controller setting of “9”); M1, once or twice daily manual irrigation event typical of good farmer management. The soil moisture sensor relates the dielectric constant of the soil to the amount of moisture present.

Automatically irrigated treatments consisted of one valve irrigating all replicates. The sensor was buried in one of the replicated plots 10 cm below the soil surface as suggested by the manufacturer. Typical, farmer drip irrigation management consisted of 60 minutes of irrigation daily when vegetables were in the first third of their growth, 60 minutes twice daily at the beginning of fruit set, and 90 minutes two times each day during fruit set and harvesting. Totalizing flow meters were installed on each treatment and water usage was recorded daily.

Time domain reflectometry (TDR) probes (Model CS-615, Campbell Scientific, Inc., Logan, UT) were installed at two depths in each plot, 15 cm and 30 cm, to monitor soil moisture status throughout the season.

Soil samples were collected from each plot prior to planting and every two weeks of the bell pepper crop. Samples were collected every 30 cm down to 150 cm. Samples were refrigerated for transport to the laboratory. Samples were extracted and analyzed for water content, NO_3-N and NH_4-N at the University of Florida Analytical Research Laboratory in Gainesville, FL following standard methods and procedures.

A concentrated, water-soluble dye was injected into the drip irrigation system several times during pepper production.

Total and marketable yield was determined at harvest.

Principle Findings and Significance:

Green bell peppers were transplanted on March 26, 2003. Shortly thereafter, nighttime air temperatures dipped below freezing which damaged the transplants. This caused a two week delay in normal pepper growth. The irrigation treatments were initiated after two weeks of time based irrigation to establish the plants. By early May it was clear that the automatic irrigation valves were not working properly and that the plants were stunted due to the freeze in early April. However, it is not uncommon to have to make adjustments to the valves early in the season to optimize their performance. In previous work, the valves performed the best at the middle and end of the season when water use was the greatest. In early June several intense thunderstorms resulted in lightning strikes on the research site. This irreparably damaged the soil moisture based irrigation control valves and 8 of the buried TDR soil moisture sensors. During this same time period, there were problems with the farm irrigation system that resulted in foreign material being injected into the drip system. This resulted in uneven and unpredictable clogging of the drip tubing. As a result of this combination of setbacks, yields were approximately half typical state yields. Variation in the yield data prevented detection of statistically significant differences across the treatments. In addition, the automatically initiated irrigation treatments used more irrigation water than the manual treatment due to valve failure in the middle of the season.

As a result, a no-cost extension has been requested to repeat the project in 2004.

Student involvement

One Ph.D. student, one master's student, and three undergraduate students assisted in the project.

Sustainable Land Application- Conference Support

Basic Information

Title:	Sustainable Land Application- Conference Support
Project Number:	2003FL39B
Start Date:	3/1/2003
End Date:	2/29/2004
Funding Source:	104B
Congressional District:	6th
Research Category:	Not Applicable
Focus Category:	Non Point Pollution, Waste Water, Agriculture
Descriptors:	
Principal Investigators:	George A. O'Connor

Publication

Title: Sustainable Land Application – Conference Support

Focus Categories: NPP, WW, AG

Keywords: Animal wastes, biosolids, effluents, waste disposal, pathogens, metals, nutrients, organic compounds, policy

Duration: 03/01/2003 – 02/29/2004

Principal Investigator: George A. O'Connor

Congressional District: 6

Problems and Research Objectives:

Land application of non-hazardous materials (e.g., animal manures, biosolids, wastewater effluents, etc.) remains the most practical and economic means for farmers and municipalities to dispose of wastes, while benefiting soil fertility and soil physical and microbial properties. Knowledge and understanding of the numerous waste constituent reactions in soil are necessary, however, to make the practice sustainable. Years of research have generated the needed information for many waste constituents, but the information tends to be waste-specific, known primarily to scientists working with specific wastes, or completely lacking, e.g., about "emerging" pathogens. Presented together, this information would promote environmentally wise and sustainable land application, improve scientific/regulatory awareness of what is known, and identify research areas of high priority. We convened an international conference in January 2004 in Florida to accomplish these lofty goals. Project funds were used in partial support of the conference. Conference objectives were to:

1. Review fundamental and specific soil reactions of non-hazardous waste constituents (nutrients, organics, metals, and pathogens).
2. Improve (and extend to various audiences) understanding of contaminant reactions in soils, emphasizing the commonalities of soil reactions among wastes.
3. Synthesize multi-disciplinary information and characterize the "state-of-the-science" for land application. ("What do we know?").
4. Identify high priority and critical research needs. ("What needs to be learned?").
5. Promote intra- and inter-disciplinary approaches to solving problems of waste disposal/utilization in a sustainable manner.

Methodology:

Details of the conference format, including the agenda and a list of attendees, are given on the conference website (www.conference.ifas.ufl.edu/landapp). Extended abstracts of the plenary talks and abstracts of all other presentations, including poster presentations were made available in a book of abstracts to attendees.

Experts on soil reactions of metals, nutrients, pathogens, and organic compounds collectively prepared state-of-the-science summaries of research on constituents in

various non-hazardous wastes. With audience participation, high priority research needs were identified. Regulators and other waste management professionals were on hand to guide science interpretation and research agendas for the future.

Principal Findings and Significance:

State-of-the-science summaries and future research priorities were prepared and subjected to audience review and input the last day of the conference. The summaries are available on the conference website. Additionally, presenters were encouraged to prepare journal articles for possible publication in a national, peer-reviewed journal, Journal of Environmental Quality (JEQ). Those papers accepted will be published as a group in forth-coming issue of the journal.

Student Involvement:

Two graduate students (1 PhD and 1 MS) directly assisted in conference logistics. Another 9 PhD students presented poster papers on their research.

Characterizing the Spatial Distribution and Connectivity of Wetlands in the Fisheating Creek Basin, Florida

Basic Information

Title:	Characterizing the Spatial Distribution and Connectivity of Wetlands in the Fisheating Creek Basin, Florida
Project Number:	2003FL40B
Start Date:	3/1/2003
End Date:	2/29/2004
Funding Source:	104B
Congressional District:	6th
Research Category:	Not Applicable
Focus Category:	Hydrology, Wetlands, Surface Water
Descriptors:	
Principal Investigators:	William R. Wise

Publication

1. Wise, William R., and Raleigh D. Myers, Modified Falling Head Permeameter Analyses of Soils from Two South Florida Wetlands, Journal of the American Water Resources Association, 38(1), pp. 111-117, 2002.

Title: Characterizing the Spatial Distribution and Connectivity of Wetlands in the Fisheating Creek Basin, Florida

Focus categories: HYDROL, WL, SW

Keywords: Wetlands, Geographic Information Systems, Watershed Management.

Duration: 03/01/2003-2/29/2004

Principal investigators: William R. Wise, Andrew L. James, Douglas T. Shaw

Congressional district: 6

Problems and Research Objectives:

The natural hydrologic settings of the Fisheating Creek and Kissimmee River basins in Glades, Highlands, Polk, Okeechobee, and Osceola counties, Florida (Figure 1), were significantly altered over the last century through wetland drainage. This drainage was done to increase the amount of arable land for cattle grazing, vegetable and fruit production, and tree farms, as well to provide some measure of flood control for the basin. This alteration of the natural hydrologic setting has been successful in providing those benefits, but it has had the undesirable side effect of causing pronounced habitat degradation. Channeling of surface water into networks of artificial ditches and canals, which feed into Fisheating Creek, has sharply increased peak flows in the creek after rainfall events. This results in a more "flashy" hydrograph, in which the time lag between a rainfall event and peak flow occurring in Fisheating Creek is dramatically shortened. This heightened response has the effect of significantly increasing contaminant (particularly phosphorous) loads in the creek, which drains into Lake Okeechobee. During the course of this work, the principal investigators of this project worked with The Nature Conservancy (TNC) on a project that involves describing hydrologic processes at up to the landscape scale in the Fisheating Creek basin. The goal of the TNC project was to investigate how potential changes in land use practices and/or landscape renewal projects will increase watershed storage following rainfall events, which will result in more natural hydrographs and reduced contaminant loads into Lake Okeechobee.

Figure 1. Location of Fisheating Creek Basin.

Methodology:

Impacted wetlands were identified using the Geographic Information System ArcGIS. This identification was done using a modified version of the South Florida Water Management District (SFWMD) soils coverage, which indicates whether soils are hydric in nature or not. In addition, a coverage of wetlands from the National Wetlands Inventory (NWI) was examined as well. Wetlands were determined to be impacted if:

1) A particular wetland on the NWI coverage was indicated to be drained and/or ditched, or

2) An area underlain by hydric soils was classified as "Upland" by the NWI coverage, indicating that the area had historically been a wetland before modification.

After this identification process was completed, the hydrologic modeling system MIKE-SHE was used to develop and model the hydrologic characteristics of the basin. This model addresses many of the physical processes of interest, such as diffusional

surface flows, flow through variably saturated media, evapotranspiration, and saturated groundwater flow. After the hydrologic model was constructed and verified, simulations were run with the wetlands in a "restored" condition, meaning that rainfall was allowed to accumulate naturally in wetlands rather than routed through the ditch and canal networks into Fisheating Creek. This was accomplished by using a feature of MIKE-SHE that models agricultural drains. Where an area is specified as being drained, water in the surficial aquifer within a specified distance of the ground surface is drained from the aquifer and routed either to the nearest stream or canal, or to the edge of the model, depending on which is closest. The "restored" condition was simulated by removing the drains. Hydrographs on the main branch of Fisheating Creek (at Palmdale, where a USGS gaging station is located) were compared using the current ("unrestored") and "restored" settings.

In concert with this, the spatial distribution of wetlands within the basin was determined using the freely available program FRAGSTATS (McGarigal and Marks, 1994.) To do this analysis, the SFWMD soils coverage was used. A new coverage was derived containing only soils that are hydric in nature. From this coverage, an ArcGRID file (raster) was created and classified according to the SFWMD Landscape Position Classification for soils occurring within the district. This classification contains four general categories of hydric soils, three of which occur in the Fisheating Creek basin:

- Landscape Position (LPOS) Classification 5: Muck Soils.
- LPOS Classification 6: Sand Depression soils.
- LPOS Classification 7: Flats Soils.

Generally, the muck soils are found underlying areas that are under water for most or all of the year, while the sand depression soils are frequently found in drainage areas or adjacent to some muck soils. Flats soils are located between depressional landscapes and upland areas, and are generally regarded as transitional areas that experienced only seasonal inundation. Those wetland areas that were usually flooded year-round and are underlain by muck soils are isolated in extent and form a patchy, disconnected map pattern (Figure 2). These soils commonly occupy the "core" of a wetland complex, which is fully or partly surrounded by transitional areas underlain by flats soils. The transitional areas form larger, better connected areas. Figure 1 shows the ArcGrid map. Note that the sand depression soils and the muck soils tend to form somewhat more "blotchier" areas than the flats soils, which are better connected. The major exception to this is along the main branch of Fisheating Creek as well as along numerous smaller tributaries, which are almost entirely underlain by soils classified as sand depression, making long, continuous corridors.

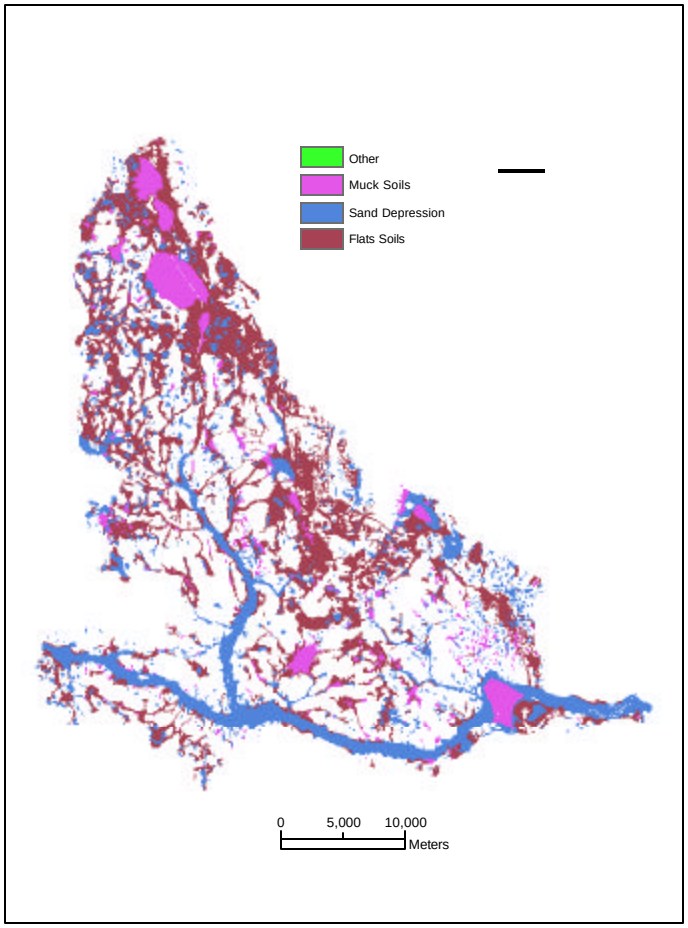
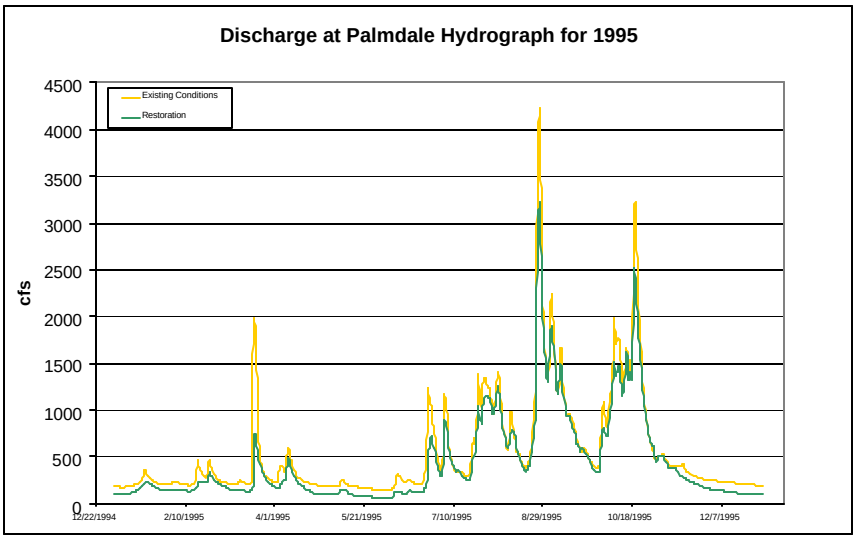
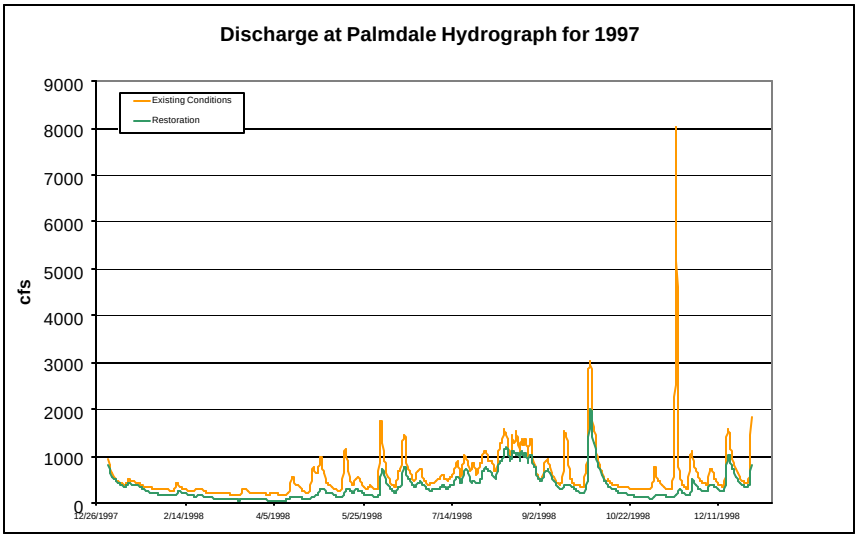


Figure 2. Hydric Soils in Fisheating Creek Basin

Principal Findings and Significance:

During the identification process, it was determined that approximately half of the areas in the Fisheating Creek Basin underlain by hydric soils are no longer classified as wetlands, and thus are potential candidates for remediation. Remediation was simulated in the hydrologic models using the technique discussed in the previous section, i.e., removal of agricultural drains. Hydrographs of model years 1995, 1997, and 2000 are shown in Figures 3a-c, respectively. For the model year 1995 (above average precipitation), restoration resulted in a significantly lower amount of water (approximately 78,600 acre-feet) passing the gage at Palmdale. For the model year 1997 (precipitation was influenced by El Nino), restoration resulted in a savings of approximately 113,000 acre-feet, while for model year 2000, restoration resulted in a savings of approximately 60,000 acre-feet.





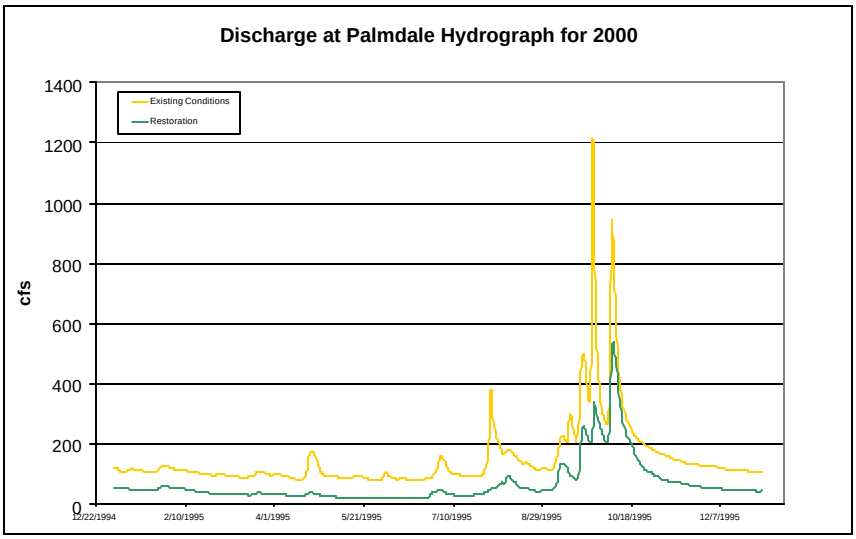


Figure 3. Hydrographs for Simulation Years 1995, 1997, and 2000

Results from FRAGSTATS show that there are significantly more patches of sand depressional soils than either muck soils, or flats soils. The Landscape Shape Index (LSI in Table 1) for flats soils is higher than for either muck soils (the lowest), or depressional sands, indicating that the landscape pattern of flats soils is somewhat "clumpier" than depressional soils, and significantly moreso than muck soils. The mean of the perimeter-to-area ratio (PARA_MN) is higher for flats as well, indicating that distributions of flats soils tend to be more stretched out (rather than circular or nearly so) than the other types of soils. The "core area" of flats soils (measured in hectares) is higher than depressional soils, and significantly higher than muck soils, indicating that each patch of flats soil tends to be larger than the other types of soils. This is also reflected in the mean of the core area (CORE_MN) which is simply the total core area divided by the number of patches. The parameter CLUMPY is another measure of disaggregation of patch types, i.e., a lower value of CLUMPY (the parameter ranges between -1 and 1) indicates that the class type is more disaggregated. This measure is inversely related to LSI. Lastly, COHESION measures the physical connectedness of the particular soil type; higher values indicated greater values of connectedness. By this measure, areas underlain by flats soils have a slightly greater degree of connectedness than depressional soils, and a significantly greater degree of connectedness than muck soils.

TYPE	NP	CA	LSI	PARA_MN
Flats	319	29063	49.7302	335.3471
Mucks	364	6328	20.1787	285.5429
Sand dep.	1277	17117	42.813	320.2862

TYPE	TCA	CORE_MN	CLUMPY	COHESION
Flats	17939.5	56.2367	0.679	99.407
Mucks	4315.25	11.8551	0.8617	93.4783
Sand dep.	10281.75	8.0515	0.7617	98.1592

Table 1. FRAGSTATS Output for LPOS Classes

Student Involvement:

One master's student was involved in this effort.

Information Transfer Program

During FY 2003, the Florida WRRC actively promoted the transfer of the results of water-resources research to water-resource groups in Florida. The target audience was the scientific and technical community who address Floridas water problems on a professional basis. Specific activities that were part of this task included maintaining an updated mailing list with email addresses and a web-based home page. The email list and home page were used to provide timely information about research proposal deadlines, conference announcements and calls for papers, and other water-related activities. The home page describes ongoing research at the WRRC and lists research reports and publications that are available. Also, the home page is used to list research reports and publications that are available through the WRRC and elsewhere, and it provides links to other water-resource organizations and agencies, including the five water management districts in Florida and the USGS. The WRRC continues to maintain a library of technical reports that have been published in past years by the WRRC. Copies of these reports can be checked out by researchers. Also, copies of reports are distributed upon request with a nominal charge make to cover the cost of reproduction and mailing. As newer reports become available, electronic versions of these reports will be made available for distribution by downloading from the WRRC home page. Financial support was provided for publishing research results in refereed scientific and technical journals and conference proceedings. Dr. Louis H. Motz, who is the Director of the WRRC, was the Principal Investigator for the Information Transfer task.

Information Transfer

Basic Information

Title:	Information Transfer
Project Number:	2003FL42B
Start Date:	3/1/2003
End Date:	4/28/2004
Funding Source:	104B
Congressional District:	6th
Research Category:	Not Applicable
Focus Category:	None, None, None
Descriptors:	
Principal Investigators:	louis.h.motz.1

Publication

1. Dogan, A., and Motz, L. H. 2003. Saturated-Unsaturated 3-D (SU3D) Groundwater Model, I: Development. Journal of Hydrologic Engineering, American Society of Civil Engineers (ASCE), (accepted for publication).
2. Dogan, A., and Motz, L. H. 2003. SU3D Groundwater Model, II: Verification and Application. Journal of Hydrologic Engineering, American Society of Civil Engineers (ASCE), (accepted for publication).
3. Tiruneh, N. D., and Motz, L.H. 2003. Three-Dimensional Modeling of Saltwater Intrusion in a Coastal Aquifer Coupled with the Impact of Climate Change. World Water & Environmental Resources Congress 2003, American Society of Civil Engineers, Philadelphia, PA, June 23-26.
4. Motz, L. H., Yurtal, R., and Tiruneh, N. D. 2003. Simulation of Three-Dimensional Variable-Density Groundwater Flow and Transport along the Mediterranean Coast of Turkey. Second International Conference on Saltwater Intrusion and Coastal AquifersMonitoring, Modeling and Management (SWICA-M3), Merida, Yucatan, Mexico, March 30-April 2.
5. Motz, L. H., and Dogan, A. 2003. North-Central Florida Active Water-Table Regional Groundwater Flow Model (Draft Interim Report). St. Johns River Water Management Disitrict, Palatka, FL, pp. 1-107, November.

Student Support

Student Support					
Category	**Section 104 Base Grant**	**Section 104 RCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	3	0	0	0	3
Masters	3	0	0	0	3
Ph.D.	2	0	0	0	2
Post-Doc.	0	0	0	0	0
Total	8	0	0	0	8

Notable Awards and Achievements

Publications from Prior Projects