Florida Water Resources Research Centter

Annual Technical Report

FY 2000

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 1964 and coordinates water-resources research and technology transfer as authorized by the funding, acts as a 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 part by Section 104 of Public Law 98-242 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

Basic Information

Title:	Phosphorus Contamination Potential of Groundwater Associated with Land Application of Domestic and Animal Waste Products in Florida
Project Number:	FL-02
Start Date:	3/1/2000
End Date:	2/1/2001
Research Category:	Not Applicable
Focus Category:	Non Point Pollution, Water Quality, Hydrogeochemistry
Descriptors:	Waste Disposal, Leaching, Adsorption, Soil Chemistry, Sludge
Lead Institute:	Water Resources Research Center
Principle Investigators:	George A. O’Connor, Dibyendu Sarkar

Publication

1. Elliott, H.A., G.A. O’Connor, and S. R. Brinton. 2001. Phosphorus leaching from biosolids-amended sandy soils. In preparation for J. Environmental Quality.

Project Number: FL-02
Start Date: 3/00
End Date: 2/01

Title: Phosphorus Contamination Potential of Groundwater Associated with Land Application of Domestic and Animal Waste Products in Florida

Investigators: Dr. G.A. O'Connor, Dr. D. Sarkar

Congressional District: #5

Focus Categories: NPP, WQL, HYDGEO

Descriptors: Waste Disposal, Leaching, Absorption, Soil Chemistry, Sludge

Problem and Research Objectives: Growing concern over the buildup of excessive P in soils as a result of waste applications has led to regulatory changes that could dramatically alter land-based disposal of animal manures and biosolids. The regulations have been enacted with surprisingly little appreciation for, or documentation of, differences in waste P-source solubility, reactions with soil, and susceptibility to leaching. The purpose of our research was to supply such information for representative waste P-sources and soils of Florida prone to leaching.

Objectives:

1. Determine the solubility and leachability of P in biosolids, manures, and biosolids/manure-amended soils and contrast these characteristics with P-fertilizer systems. We then sought to quantify the relationship between various measures of P solubility and P leachability.

2. Determine P retention characteristics of waste P-source amended soils and identify factors influencing P retention.

Methodology: Laboratory and greenhouse column studies were conducted to characterize P forms and leachability of eight biosolids, chicken manure (CM) and commercial fertilizer (triple superphosphate, TSP). Bahiagrass (*Paspalum notatum Flugge*) was grown for four (4) months on two (2) acid, P-deficient Florida sands, representing both moderate (Candler series, hyperthermic, Typic Quartzipsamments) and very low (Immokalee series, hyperthermic, Arenic Aloquods) P-based and N-based nutrient loadings, respectively, for bahiagrass. Leachate-P was quantified as to amount and form and related to waste P-source characteristics. Soil P-retention was quantified in a single point isotherm and related to soil and P-source characteristics.

Principal Findings and Significance: Phosphorus retention in Florida soils is primarily associated with Fe and Al oxides, and earlier work suggested that waste P-sources high in Fe and Al could increase P retention in poorly P-sorbing soils. As expected, there was no improvement in P retention by waste-amended Candler soil because the soil apparently possesses sufficient Fe and Al to mask waste-Fe and Al additions. Surprisingly, there also was no improvement in P retention in the poorly P-sorbing Immokalee soil. Nevertheless, changes in soil PSI values reflected treatments impacts on P leaching in the Immokalee soil reasonably well.

Data trend interpretations from this one-year study must be tempered until additional wastes and soils can be examined. Nevertheless, we regard the trends as sufficiently clear to justify the following generalizations. In moderately-to strongly-P sorbing soils, control over waste-P leaching is primarily soil-based, and leaching is minimal. However, excessively high P application rates of soluble P-sources (TSP) can override even moderate soil sorption capacities. In poorly P-sorbing soils (e.g., Immokalee), control over P leaching appears to be P-source controlled, primarily by the solubility of the P-source. Highly soluble P-sources (e.g., TSP, chicken manure, and some biosolids) applied at high P rates can yield significant amounts of leachable P.

Basic Information

Title:	Modeling the Fate of Reclaimed Water Constituents after Application to Tree Crops
Project Number:	FL-04
Start Date:	3/1/2000
End Date:	2/1/2001
Research Category:	Not Applicable
Focus Category:	Water Quality, Nutrients, Models
Descriptors:	Wastewater Irrigation, Water Reuse, Water Quality Modeling, Phytoremediation, Nutrients, Groundwater Recharge, Solute Transport, Irrigation
Lead Institute:	Water Resources Research Center
Principle Investigators:	Donald L Rockwood, Gillian R Alker

Publication

Project Number: FL-04
Start Date: 3/00
End Date: 2/01

Title: Modeling the Fate of Reclaimed Water Constituents after Application to Tree Crops

Investigators: Dr. Donald L. Rockwood, Dr. Gillian R. Alker

Congressional District: 5

Focus Categories: WQL, NU, MOD

Descriptors: Wastewater Irrigation, Water Reuse, Water Quality Modeling, Phytoremediation, Nutrients, Groundwater Recharge, Solute Transport, Irrigation Scheduling

Problem and Research Objectives: Recent increased eutrophication of Florida's surface-water resources has resulted from the discharge of nutrients mainly from sewage effluent into rivers and lakes. This has lead to the active promotion of methods other than river discharges, such as reuse of reclaimed water for agricultural irrigation and use of land application systems such as rapid infiltration beds (RIBS), by the Florida legislature (Florida Statutes, 1999). However, if application of reclaimed water to land is not carefully managed, it has the potential to impact groundwater resources, increasing nitrate and salt contents of water which may be extracted for potable use. The primary source of drinking water in much of Florida is the upper Floridian aquifer, which lies beneath the surficial aquifer. However, the upper Floridian aquifer is often poorly confined and prone to contamination from the surficial aquifer. In a recent study (USGS, 1998), surficial groundwater samples were taken from urban, forest and agricultural areas of the Georgia-Florida coastal plain. Twenty percent of the surficial aquifer samples taken from agricultural areas exceeded the USEPA nitrate standard for drinking water of 10 mg L^{-1} NO_3–N. The source of this nitrate was considered to be inorganic fertilizer and animal wastes which have been applied at high levels over several years. Large-scale irrigation of reclaimed water to agricultural crops in Florida has the same, if not greater, potential to impact groundwater resources. Continuously wet soil greatly increases the occurrence of rainfall induced leaching from soil, even if the irrigation supply is matched to crop water demand.

Estimating the concentrations of nitrate and salt in groundwater recharge from reclaimed water is a complex problem. It is dependant on the hydraulic loading, amount of rainfall, evaporation and transpiration of the crop, and on an intricate series of processes which transform nitrogen (N) species in the unsaturated and saturated zones. Plant uptake is an important nutrient removal mechanism that can be relatively easily manipulated by selecting plants that have a high demand for both water and nutrients. However, this demand is highly dependant on plant growth, which in turn is related to weather, seasonal effects, and a number of other factors. The complicated nature of the soil-plant-reclaimed water system outlined above necessitated the development of mathematical models to assist in understanding and managing the processes that control salt and nitrate leaching to groundwater.

Intensive cultivation of fast growing tree species such as poplar (*Populus*), *Eucalyptus* and willow (*Salix*) is a viable and developing alternative to conventional agricultural management and offers diversification of land use into non-food commodity crops. Using silvicultural systems known as short rotation woody crops (SRWC), in which densely planted trees are harvested on a cycle of less than 10 years, these species can have large water and nutrient demands, characteristics that can be utilized in the phytoremediation of reclaimed water. Another important environmental benefit associated with the production of woody crops is that wood chips can be co-fired with coal for energy production. Woody biomass is a carbon (C) neutral fuel, i.e., the quantity of C released to the atmosphere on its combustion is equal to the quantity removed from the atmosphere during plant growth. Potentially 10% of Florida fossil fuel use may be displaced by the use of woody biomass, reducing CO_2 emissions to the atmosphere by up to 90,871 metric tons per year (Segrest, 1999).

The main objective of this research project was to develop a simulation model to predict water, chloride, and nitrate transport and fate after application of reclaimed water to a 2.6 ha plot of fast growing trees located at Water Conserv II near Orlando, Florida. A model could aid water treatment facilities such as Water Conserv II by assisting in scheduling water applications, minimizing the impact of nitrate and chloride leaching on the water quality of the surficial aquifer while still meeting the crop demands for water and nutrients.

Methodology:

A 2.8 ha plantation of SRWCs was established at Water Conserv II in spring 1998. Tree growth, tree water-use, soil composition, and soil water composition were monitored since establishment. Investigations into the effect of tree species and silvicultural treatment options on woody biomass production and water treatment identified a high degree of system complexity, warranting further investigation using modeling techniques. An assessment of existing models, which simulate all or part of the soil-tree-water system, identified one model (Agricultural Productions System Simulator, APSIM) as highly suitable for modeling conditions at Water Conserv II. APSIM was parameterized using data collected from WaterConserv II during 1998-2000 and the modeling results were validated against experimental tree plot growth, transpiration, nutrient uptake and nutrient leaching results.

Principal Findings and Significance:

The greatest height and woody biomass production was generated by *Eucalyptus grandis* (*EG)* with effluent plus compost plus mulch (**ECM)** treatment, followed by *EG* with effluent plus compost (**EC)**, cottonwood (*CW)* with **ECM** and *CW* with **EC**. After 3 years of growth, *EG* had produced on average 119% more woody biomass compared to *CW* for **EC** and **ECM** treatments. Compost application increased yields by 131%, mulch by 76%, and mulch plus compost by 158% compared to reclaimed water application alone (**E**). A significantly increased supply of macro and micro nutrients provided by compost addition supplemented the reclaimed water derived nutrients to augment yields in compost treated plots.

CW trees treated with **EC** transpired a total of 1233mm between 17th May and 19th December, accounting for 33% of the total water applied. Stem N concentrations were higher in *CW* compared to *EG*, resulting in greater removal of N by *CW* after the second growing season. However by the third growing season, higher biomass production in *EG* over-compensated for lower stem N concentrations, resulting in a 10% higher total N offtake in *EG*.

In the absence of trees, N leaching at 5 feet below the soil surface increased by 53%. N leaching was not significantly affected by species but was strongly controlled by soil amendments, such that compost increased and mulch decreased N leaching from the root zone. Plots treated with **E** and **EM** removed proportionally more N than water from the reclaimed water, such that the concentration of the water leached from the root zone was lower than the N concentration of the applied reclaimed water. The N concentration of water leaching from **EC** and **ECM** treated plots was generally higher than the concentration of the applied reclaimed water.

The APSIM for effluent model successfully simulated long-term water use in *CW* and estimated that *EG* could transpire up to 28% more water than *CW*. The model also estimated that up to 85% of the total N applied in reclaimed water could be removed by application to SRWCs using *EG* with **EM** treatment. Where compost was added, N leaching was predicted to increase by between 395 and 423% compared to **EM** treatment. Selection of species and treatment options for SRWC plantations irrigated with reclaimed water is highly dependent on the objectives of the system. To maximize woody biomass production and /or water use, *EG* with **ECM** treatment is recommended, but if the principal objective of the SRWC-reclaimed water system is to maximize N removal, *EG* with **EM** is recommended to limit the input of additional compost derived N to the system.

Basic Information

Title:	Development of Multiple Process and Multiple Scale of Hydrologic Models
Project Number:	FL-03
Start Date:	3/1/2000
End Date:	2/28/2001
Research Category:	Not Applicable
Focus Category:	Hydrology, Models, Water Supply
Descriptors:	Hydrologic Models, Ground Water Hydrology, Watershed Management
Lead Institute:	Water Resources Research Center
Principle Investigators:	Andrew I James, Wendy D Graham

Publication

Project Number: FL-03

Start Date: 3/00

End Date: 2/01

Title: Development of Multiple Process and Multiple Scale Hydrologic Models

Investigators: Andrew I. James, Wendy D. Graham, Kirk Hatfield

Congressional District: 5

Focus Categories: HYDROL, MOD, WS

Descriptors: Hydrologic Models, Ground Water Hydrology, Watershed Management

Problem and Research Objectives: The natural hydrology of south Florida has been extensively altered though channelization to provide adequate water for urban growth and agriculture and to provide flood protection to the area. Currently, water resource management in south Florida is governed by a number of federal, state, and county agencies. These agencies have developed or adopted hydrologic models to address a diverse set of needs. These range from large-scale models used to estimate impacts of alternative water management practices across all of south Florida to field-scale models used to predict local impacts such as flooding or agricultural production. At present, there is no feedback mechanism in place for dynamically conveying information across the wide range of scales addressed by this spectrum of models. Instead, static methods are used, where results from larger-scale models are used as boundary conditions for smaller-scale models. This ignores both the problem of upscaling parameters such as hydraulic conductivity, which may be highly variable over small scales, as well as the problem of aggregating a variety of coupled hydrologic processes occurring over a wide range of temporal and spatial scales into a coherent and accurate model of a hydrologic system.

The primary goal of this project is to investigate how hydrologic processes such as ground water flow, river/canal flow, overland flow, infiltration, evapotranspiration, etc., are manifested across a broad range of spatial and temporal scales. Our main focus is on how these processes interact across scales, as well as on understanding how agricultural, urban, and/or natural ecosystems impact-and are impacted by- hydrologic processes at a variety of scales.

The objectives of this research are to:

- Establish a framework for the efficient exchange and integration of hydrologic information across a wide range of spatial and temporal scales.
- Develop methods for upscaling input parameters and predictions from detailed local models for use in larger-scale sub-regional and regional models.
- Develop a hydrologic model that incorporates these methods and is capable of making predictions over a range of scales.
- Apply this method to areas in southern Florida where agricultural, urban, and environmental interests must share limited water resources.

Methodology: To address these needs, we have undertaken development of a hydrologic model that simulates a number of hydrologic processes. The specific processes modeled for this project are:

1) Unconfined saturated ground water flow.
2) Infiltration through the vadose zone.
3) Evapotranspiration.
4) Overland flow.

Each of these processes is modeled in a separate physical domain, and linkage between the domains is accomplished through matching of fluxes through the domain boundaries. The primary objective of our model is to arrive at a solution for the dependent variables (e.g. head and flux) within each subdomain that balances the flux of water between all the domains. This is accomplished using an iterative process that solves the governing equations simultaneously in each subdomain.

Principal Findings and Significance: One of the most challenging aspects of water resource management is the accurate modeling of a wide range of interrelated processes such as ground water flow, infiltration, evapotranspiration, overland flow, river/canal flow, rainfall, etc. Interactions between these processes include the exchange of water between rivers, lakes, and ground water, the relation between the soil moisture content and soil type and the amount of runoff generated from a rainfall event, the partitioning of water in the unsaturated zone between flow into the water table and plant uptake, etc. Even more complexity is added by the large scale of the problem, which can cover hundreds or thousands of square miles, and the fact that the results must be provided to a wide variety of diverse interests. If the appropriate balances between agricultural and urban water use and environmental protection and restoration are to be maintained, these processes and interactions must be modeled in a realistic manner. One of the primary difficulties in the development and application of a large-scale hydrologic model is that the relevant processes and interactions occur over a wide range of spatial and temporal scales. This leads to two related issues that must be addressed by the model developer, namely, the related matters of scale-dependent spatial variability and aggregation of the various relevant processes over the range of scales.

The first issue arises since hydrologic parameters such as soil type or hydraulic conductivity can exhibit a tremendous amount of spatial variability, in many cases over a range of several different scales. Other driving processes such as rainfall, evapotranspiration, etc., can also be highly variable in time and space. The second issue of aggregation deals with the matter of how to incorporate a variety of hydrologic processes occurring over a wide range of temporal and spatial scales into a coherent and accurate large-scale model of a hydrologic system. We are thus faced with the question: What is the appropriate method to generate a realistic hydrologic model given this complex hierarchy of parameters and scales? Any model that attempts to answer this question must address the problem of how to convey information produced at one scale and incorporate that information back into the model at another scale. It is obvious that such a model will require a complex network of feedback between the relevant processes and interactions over many spatial and temporal scales. Given the amount of information required in a large-scale hydrologic model, the solution to this problem is far from straightforward. Efficient communication of the information across the various scales and processes is necessary if a realistic solution is to be obtained at a reasonable cost. Our model starts with developing numerical models for each of the processes listed above in their respective subdomains, and then seeks to link the processes together through the shared flux terms at the subdomain boundaries.

Modeling unconfined saturated ground water flow: To model unconfined ground water flow, we have developed a three-dimensional mixed finite element computer code. This code is designed to model saturated ground water flow in a phreatic aquifer where the position of the water table is not known *a priori*. The boundary of the model domain can be divided into four separate parts: a boundary where a fixed-head boundary condition is enforced, a boundary where a fixed flow (possibly no-flow) boundary condition is enforced, a seepage face where the head on the boundary is equal to the elevation z of the boundary, and the phreatic surface, where two conditions must be enforced. There are several advantages to using a mixed finite element method rather than standard head-based approximations to ground water flow. First, the mixed finite element method gives a much better approximation of the flux term, since numerical differentiation of the head is not required. Second, the free surface boundary condition in the mixed approach is more straightforward than head-based methods, where a complicated non-linear boundary condition for the head gradient must be satisfied.

Our code uses a three-dimensional tetrahedral mesh, and it can utilize either Raviart-Thomas-Nedelec (RTN) elements of order 0 or Brezzi-Douglas-Marini (BDM) elements of order 1. On the same mesh, the higher order elements naturally give a better approximation but of course carry a higher computational burden. We have found that that on a moderately fine mesh, the RTN elements of order 0 give a sufficiently accurate approximation. In this work, water in the saturated zone interacts only with water in the unsaturated zone, or directly with the ground surface if the water table reaches the surface. In future work, we will address direct exchange between the saturated zone and rivers (or canals) and lakes.

Modeling flow in the unsaturated zone: The unsaturated zone is the connection between saturated zone and the ground surface. Precipitation or water applied during irrigation percolates into the saturated zone through this zone. For this study, flow in the unsaturated zone is modeled using a one-dimensional form of Richards' equation. There are several forms of Richards' equation that have been used to model transport in the unsaturated zone, which are classified as:

1) Water-content based algorithms;
2) Pressure-based algorithms;
3) Mixed-form equations.

Water-content based algorithms, as the name implies, use the soil water content as the dependent variable. These can give better mass-balance performance when compared to pressure-based methods when modeling infiltration into very dry heterogeneous soil. Unfortunately, water content based algorithms can not be used for problems containing fully saturated regions since the soil-water diffusivity function goes to infinity for commonly used soil-moisture models. Pressure-based solutions to Richards' equation can be used for both saturated and unsaturated soils. However, when modeling steep wetting fronts moving into very dry soil, pressure based algorithms usually require small time steps in order to maintain stability and minimize truncation errors. As a compromise, *Celia et al*. [1990] proposed a modified numerical approach to alleviate the mass balance problem. This approach introduced a mixed-from equation, in which storage term is expressed in moisture content while flux terms are expressed in head potential. Approximations using this mixed formation are mass conservative. However, mixed–form algorithms are not applicable in the presence of layered soils since the soil-moisture content may not be continuous across soil interfaces.

The head-based form of the governing equation was selected as the governing equation for this project because the pressure is continuous in multi-layered soil and because the head-based form can be used in modeling both saturated and unsaturated flow. Numerical experiments in this study show that an "L2" lumping scheme, combined with a fully implicit time-stepping scheme, result in good mass balance. Our numerical experiments also show that lumped method can increase the rate of convergence and stability of the numerical scheme. Usually, the upper boundary for a 1-D vertical model is specified flux unless rainfall leads to ponding water on soil surface. The specified flux is either the precipitation rate or the evaporation rate. Evaporation from the soil surface is controlled by atmospheric and soil conditions. For soil covered with vegetative canopies, water uptake through roots needs to be considered.

At the lower boundary (the interface with the water table), the head is set to zero, and the flux at the bottom boundary is solved for. This is used as a recharge term for the saturated ground water component of the model discussed above.

The evaporation rate from bare soil is incorporated as a flux boundary condition for the upper boundary, and transpiration by plants is modeled as a sink within the model domain. It is possible for the top boundary condition to switch between head-controlled and flux-controlled during the solution process. For example, if the rainfall rate exceeds the maximum allowed infiltration rate, the water will pond on the soil surface and the upper boundary condition switches from flux-controlled to head-controlled. Once the potential infiltration decreases to a point less than maximum infiltration rate, the boundary condition can switch back to flux-controlled. After a heavy rainfall or irrigation, the soil is often wet enough so that water evaporates from the soil surface at a potential rate allowed by the atmospheric conditions (atmosphere controlled). In case of prolonged dry weather, the soil water pressure head at the soil surface can begin to govern the evaporation flux (a soil controlled condition). Once the soil has dried to the residual point, the soil moisture pressure is assumed to remain unchanged until potential flux decreases.

Potential evapotranspiration is distributed between the potential evaporation from the soil surface and potential transpiration by plants. The Penman-Monteith equation is used to calculate potential evapotranspiration, and the actual evaporation and transpiration is calculated as a function of the potential evapotranspiration and factors such as the surface and root resistance, saturated and relative hydraulic conductivity, root depth, soil-water potential, etc.

Overland Flow: Overland flow is a dynamic part of watershed response to rainfall and irrigation events and occurs when infiltration capacity has been exceeded. Suitable modeling of overland flow is necessary in many engineering applications:

1) Water budget studies;
2) Flood prediction;
3) Soil erosion studies;
4) Modeling of infiltration processes;

5) Modeling pollutant transport to streams and rivers; and
6) Design of runways and parking lots.

The movement of surface water can be described by continuity and momentum equations applied to an incompressible fluid in form of the Saint-Venant equations. Various simplifications can be applied to the Saint-Venant equations depending on the system being modeled: A fully dynamic model that uses the full Saint-Venant equations, a diffusion model that neglects inertial terms, and a kinematic wave model that neglects both inertial and pressure terms.

Both the kinematic wave and diffusion models have many applications in real-world modeling. The kinematic wave approximation is applicable for steep and smooth surfaces, while the diffusion wave approximation is also applicable for rough surfaces. However, the kinematic wave approximation has moderately severe limits on its applicability. Since it lacks the pressure term, it is not suited for overland flow over mild slopes, where diffusion plays a major role. Additionally, the kinematic wave approximation cannot incorporate backwater effects and it cannot model any physical attenuation to the wave profile since all the energy dissipation terms of the momentum equation have been neglected. The diffusion wave approximation neglects inertia terms like the kinematic wave approximation. However, the pressure term is kept, which makes the diffusion wave approximation applicable in a wider range of situations. Such simplifications introduce errors on the order of 5% - 10%, which are negligible in the real world [*Ahn et al*. 1993].

Areas such as south Florida are characterized by large areal extent, small slopes, widespread ponding, and slow regional flow dynamics. Kinematic wave models are inadequate for these cases because backwater effects are neglected. Compared with dynamic models, diffusion flow models offer computational advantages for areas such as south Florida. Diffusion flow models have been successfully used to simulate hydrologic processes in the Everglades, using the natural system model (NSM) and the south Florida water management model (SFWMM) developed by the South Florida Water Management District.

Information Transfer Program

Basic Information

Title:	Information Transfer
Start Date:	3/1/2000
End Date:	2/28/2001
Descriptors:	
Lead Institute:	Water Resources Research Center
Principle Investigators:	Louis H. Motz

Publication

1. Motz, L.H.; R.E. Denis, 2000, Discussion of Post Audit of a Numerical Prediction of Wellfield Drawdown in a Semiconfined Aquifer System, Journal of Ground Water, 38(1): pp. 5-6
2. Motz, L.H., 2000, Water-Budget Analysis for Lake Management, "Joint Conference on Water Resources Engineering and Water Resources Planning and Management", American Society of Civil Engineers, Minneapolis, Minnesota, poster
3. Dogan, A; L.H. Motz, 2000, Variably Saturated Three-Dimensional Evapotranspiration and Groundwater Pumping Model, EOS, Transactions of The American Geophysical Union, 81 (19): pS216 (abstract)
4. Motz, L.H.; F. Gordu, 2001, Estimates of Groundwater Discharge and Nutrient Loading to the Indian River Lagoon, St. Johns River Water Management District, Palatka, Florida, pp. 1-21
5. Motz, L.H.; A. Dogan; J. Zhong; and B.J. Watson, 2000, Revised North-Central Florida Regional Groundwater Flow Model, St Johns River Water Management District, Palatka, Florida, pp 1-118
6. Gordu, F., 2000, Simulation of Seawater Intrusion and Optimization of Groundwater Use in the Goksu Delta, Silife, Turkey, "MS Dissertation", Department of Civil Engineering, University of Florida, Gainesville, Florida

Information Transfer

Fl-05

During FY 2000, the Florida WRRC actively promoted the transfer of the results of water resources research in Florida. The target audience was the scientific and technical community who address Florida's water problems on a professional bases. Specific activities that were a 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 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 will be used to list research opportunities 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 by the WRRC. Copies of these reports can be checked out by researchers, and also they are distributed upon request at 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. Also, support was provided for printing theses and dissertations that are of interest to the target audience. Dr. Louis H. Motz, who is the Director of the WRRC, was the Principal Investigator for this task.

USGS Summer Intern Program

Student Support

Student Support					
Category	**Section 104 Base Grant**	**Section 104 RCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	0	9	0	0	0
Masters	1	4	0	0	0
Ph.D.	1	3	0	0	0
Post-Doc.		0	0	0	0
Total	2	16	0	0	18

Notable Awards and Achievements

None

Publications from Prior Projects

1. Wise, William R., and Raleigh D. Myers, Directional Dependence of Peat/Muck Hydraulic Conductivity for Two South Florida Wetlands, submitted to Journal of the American Water Resources Association, in press.
2. Carmichael W. W. et al. (in prep.) Isolation and characterization of the potent alkaloid hepatotoxin cylindrospermopsin from a Florida strain of the cyanobacterium Cylindrospermopsis raciborskii.
3. Ross, J. P., H. F. Percival, A. Woodward, D. Carbonneau, T. R. Schoeb, J. Burns, C. Williams & W. Carmichael. 2000. Alligator mortality and algal toxins: a preliminary report. American Fisheries Society, Florida chapter 20th Annual meeting March 2000. Abstract.
4. James Perran Ross, Franklin Percival, Dwayne Carbonnea, Allan Woodward & Trenton Schoeb Abstract. Investigations of Mortality and Reproductive Failure of Alligators in Lake Griffin, Central Florida. Florida Lake Management Society, 12th Annual Conference 21-24 May 2001:124
5. Ross, James Perran Central Florida Lakes Wildlife Initiative Analyses of tissue samples of alligators from Lake Griffin to examine causes of unexplained mortality. Report to Lake County Water Authority, Contract No. #00032702, 30 September 2000