Florida Water Resources Research Center
Annual Technical Report
FY 2004

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 2004, the Florida Water Resources Research Center (WRRC) supported three projects. Two of the projects were supported by funds through the 104B program, and one project was funded through the 104G program. In one of the 104B projects, the sensitivity of the hydroperiod of forested wetlands along flood plains to alterations in topographic attributes and land use was investigated by measuring landscape characteristics in these forested wetlands, understanding the dependence on surrounding landscapes, and assessing the impact of upstream agriculture and urban land uses. In the other 104B project, the delineation of areas of groundwater that are vulnerable to contamination was investigated on a watershed scale by developing and adapting a hybrid method of Neural Networks and Fuzzy Logic within a geographical information system (GIS). In the 104G project, space-based observations are being used to understand the complexity of wetland surface flow in order to better manage wetlands and water resources.

Sensitivity of the Hydroperiod of Forested Wetlands to Alterations in Topographic Attributes and Land Use

Basic Information

Title:	Sensitivity of the Hydroperiod of Forested Wetlands to Alterations in Topographic Attributes and Land Use
Project Number:	2004FL57B
Start Date:	3/1/2004
End Date:	2/28/2005
Funding Source:	104B
Congressional District:	11th
Research Category:	Not Applicable
Focus Category:	Ecology, Hydrology, None
Descriptors:	
Principal Investigators:	Mahood Nachabe, Mahood Nachabe

Publication

1. Nachabe, M. H 2006. Spatially Distributed Versus Lumped Parameter Models: A proposed Equivalence between the TOPMODEL and SCS Curve Number Method. Journal of the American Water Resources Association. In press.
2. Said, A., M. Nachabe, M. Ross, and J. Vomacka 2005. Estimating Specific Yield Using Continuous Soil Moisture Monitoring. To appear in the November-December issue of the ASCE, Journal of Irrigation and Drainage Engineering.
3. Nachabe, M. H., N. Shah, M. Ross, and J. Vomacka 2005 . Evapotranspiration of Two Vegetation Covers in Humid Shallow Water Table Environment. Soil Science Society of America Journal, 69:492-499.
4. DeSilva, M., M. H. Nachabe, J. Simunek, and R. Carnahan 2005. Simulating Root Water Uptake from a Heterogeneous Vegetation Cover using Finite Element Modeling. In press, ASCE, Journal of Irrigation and Drainage Engineering.
5. Nachabe, M. H., C. Masek, and J. Obeysekera 2004. Observations and Modeling of Profile Soil Water Storage above a Shallow Water Table. Soil Science society of America Journal, Vol. 68, No. 3.
6. Hernandez, T., M. Nachabe, M. Ross, and J. Obeysekera 2004. Runoff from Variable Source Areas in Humid, Shallow Water Table Environments. Journal of the American Water Resource Association,

vol. 39, no. 1, pp.75-85.
7. DeSilva, M. and M. H. Nachabe 2006. Influences of Land Use Change and Topographic Attributes on Hydrology of Shallow Water Table Environments. In review, Ecological Modelling.

Report for:
Vulnerability of the hydroperiod of forested wetlands to alterations in topographic attributes and land use

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This research offered a unique opportunity to enhance our understanding of the dynamics of Variable Saturated Areas (VSA). Soils in VSA are subject to routine cycles of wetting and drying which drive many ecological functions of the watershed including: maintaining a healthy hydroperiod for forested wetlands, sustaining fish and wading bird habitat, and providing sediments and saturation excess runoff to adjacent streams. Water table and soil moisture were monitored along a transect incorporating an upland area with grass and a lowland forested zone within a VSA. The objective was to understand hydrological connectivity and fluxes across distinct landscapes, and to determine how upland areas support the cycle of inundation in VSA. Detailed soil analysis was carried out to estimate the soil hydraulic properties and to fit the van Genuchten model of soil properties. Optimization algorithms were used to fine-tune the soil hydraulic parameters by matching observed and simulated ground water levels. Varying rooting depths were assigned to different segments of the spatial domain to represent the mix vegetation, which consisted of a riparian zone with relatively deep roots, and a pastureland zone with shallow roots. Two-dimensional finite elements simulations were carried with different surface cover boundary conditions to test the sensitivity of VSA and root-water-uptake to landscape change. Findings of this research were documented in six journal articles published in a diverse literature to ensure maximum impact.

Impact:
Partnerships supported through this project included technical collaborations with South Florida Water Management District, Southwest Florida Water Management District, and Tampa Bay Water. The PI worked with staff from these agencies to better achieve the goals of the project by increasing the awareness on the sensitivity of VSA to land use change. Selected staff from these agencies served as members on graduate students committees and attended professional presentations related to this project. Funding from project supported the dissertations of three graduate students. All graduate students have reached to their community by giving technical presentation and publishing in both refereed journals and conference proceedings. Output included convening a technical session by the PI at the annual AGU meeting in San Francisco in December 2003. Graduate students on this project participated in technical presentation at the annual AGU meetings, the annual AWRA conference in Miami, and the joint Conference on the Science and Restoration of the Greater Everlglades and Florida Bay Ecosystem. In addition, the PI contributed a poster presentation in the annual CSREES, National Water Quality Conference in Clearwater, Florida.

Ground Water Vulnerability Delineation Using Integrated GIS and Neuro-Fuzzy Methods

Basic Information

Title:	Ground Water Vulnerability Delineation Using Integrated GIS and Neuro-Fuzzy Methods
Project Number:	2004FL59B
Start Date:	3/1/2004
End Date:	4/28/2005
Funding Source:	104B
Congressional District:	10th
Research Category:	None
Focus Category:	Models, Nitrate Contamination, Groundwater
Descriptors:	None
Principal Investigators:	Barnali Dixon

Publication

1. Dixon, B. 2004. Ground Water Vulnerability Mapping Tool: NN and fuzzy logic: one, the other, or both?? Presentation. AWRA's 2004 Spring Specialty Conference Geographic Information Systems (GIS) and Water Resources III Water. Nashville, May 2004.
2. Candade, N. and Dixon, B. 2004. Comparison of Neural Network and Neuro-fuzzy Techniques in Ground Water Vulnerability Mapping: A Case Study. Poster. AWRA's 2004 Spring Specialty Conference Geographic Information Systems (GIS) and Water Resources III Water. Nashville, May 2004.
3. Stetson R, Dixon, B. and Candade, N. 2005. Comparison of various krigging methods for contaminated wells in Tampa Bay region FL, Florida Society of Geographers, Annual meeting. Orlando, Feb. 2005.
4. Candade, N and Dixon, B. 2004. Integrated Vulnerability Assessment of Ground Water for Hillsborough County, Florida: A Case Study. AWRA Annual Conference, Orlando, November.
5. Dixon B. and Candade N. 2005. Groundwater Contamination Mapping Using Integrated GIS and Neural Networks: A Sensitivity Analysis. Presentation. International Conference on Environmental Science and Technology. January, New Orleans.
6. Candade, N. and Dixon B. 2005. Can Logistic Regression and/or Feature Selection Methods Be Used to Predict Contaminated Wells? a Case Study of Polk County, Florida. Poster. Soil Science Society of

America. Nov. Salt lake City.
7. Application of Neural Networks, Support Vector Machines and Logistic Regression to predict contaminated wells: A comparative case study of Polk County, Florida. In preparation (to be submitted to Journal of Environmental Quality).

Ground Water Vulnerability Delineation Using Integrated GIS and Neuro-Fuzzy Methods

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Detection of potentially contaminated wells is an important component of environmental protection and management. However, contamination potential mapping is not an easy task due to inherent uncertainties. This study aims at assessing suitability of various techniques in predicting contaminated wells for example, Neuro-fuzzy (NF), Neural Networks (NN), Support Vector Machines (SVM), logistic regression and feature selection.

Contamination potential depends on complex interactions of hydro-geological variables. A large number of input variables add to redundancy, cost and time. The logistic regression, feature selection methods were used to identify critical variables in transporting contaminants in and through the soil profile. NF, NN and SVM were used to identify contaminated wells. Variables identified by logistic regression and used in this study included DRASTIC parameters, soil structure (pedality), hydrologic group, landuse, organic matter and bulk density. Well data (nitrate-N) provided by FLDEP as part of the WSRP were used in this study as target class.

The objective of this study was three- fold: (a) Analyze the input variables and identify the most significant predictors of well contamination. Perform feature selection to identify the best subset of variables. (b) Use all the input variables with the NF, NN and SVM to classify wells and compare their performances. (c) Repeat the above (step b) with the variable subset from step (a) and compare results.

Classifiers were compared based on their accuracies and parameters such as sensitivity and specificity. Free Receiver Operating Curves (FROCs) were used for evaluation of classifier performance.

Preliminary results show comparable results with the NN and SVM. Feature selection did not improve accuracy. However, it helped increase the sensitivity or the true positive rate (TPR). Thus, a higher TPR was obtainable with fewer features or variables. In this study, higher TPR is desirable since the cost of detecting a contaminated well incorrectly is far higher than a non-contaminated well going undetected. In addition, obtaining comparable results using less number of variables can reduce the cost of a project. Use of NF was not adequate for TPR. Compared to NN and SVM, NF is more sensitive to the number of wells used with the model. NN and SVM performed better with increased number of wells (larger training data sets). Integration of NF, NN and SVM models to GIS facilitated sensitivity analysis over space, however, integration of GIS with SVM was not as simple as integration with NF and NN.

Space-based monitoring of wetland surface flow

Basic Information

Title:	Space-based monitoring of wetland surface flow
Project Number:	2004FL76G
Start Date:	9/1/2004
End Date:	8/31/2006
Funding Source:	104G
Congressional District:	18
Research Category:	Not Applicable
Focus Category:	Wetlands, Surface Water, Hydrology
Descriptors:	None
Principal Investigators:	Shimon Wdowinski

Publication

1. Wdowinski, S., F. Amelung, T. Dixon, F. Miralles-Wilhelm, and R. Sonenshein, Space-based detection of surface water level changes in South Florida, submitted to Remote Sensing for Environment, 2005.
2. Wdowinski, S., F. Amelung, F. Miralles-Wilhelm, T. Dixon, and R. Carande, Space-based hydrology of the Everglades wetland, South Florida, First National Conference on Ecosystem restoration, Abstract Volume, p. 466, 2004. 44.
3. Wdowinski, S., F. Amelung, and T. Dixon, Towards operational monitoring of wetland water levels using InSAR: Applications for the Everglades Restoration Project, Eos Trans. AGU, 85(47), Fall Meet. Suppl., Abstract H23E-1169, 2004.
4. Wdowinski, S., F. Amelung and T. Dixon, S. Kim, B. Osmanoglu, M. Kartal, D. Harding, The Everglades wetlands as a laboratory for testing and calibrating the CRYOSAT hydrological applications.
5. Osmanoglu, M., D. Kartal, S. Wdowinski and T. Dixon, Altitude accuracy improvement by using a new radar altimeter simulator for ENVISAT data, 1st CRYOSAT meeting, 2005.
6. Kim, S., S. Wdowinski, F. Amelung, and T. Dixon, C-Band Interferometric SAR Measurements of Water Level Change in the Wetlands: Examples from Florida and Louisiana, IGARSS meeting proceedings, 2005.
7. Wdowinski, S., F. Amelung, and T. Dixon, Space-Based hydrology of the Everglades Wetlands, South Florida, Society of Wetland Scientists, 26th Annual Meeting, Final program and abstracts, 125, 2005.
8. Wdowinski, S., F. Amelung, T. Dixon, S. Kim, B. Osmanoglu, M. Kartal, and D. Harding, The Everglades wetlands as a laboratory for testing and calibrating space-geodetic hydrological

technologies, Eos Trans. AGU, 86(18), Fall Meet. Suppl., Abstract G23A-04, 2005.
9. Kim, S., S. Wdowinski, F. Amelung and T. Dixon, Wetlands Application of Interferometric SAR Measurements: examples from Florida and Louisiana, Eos Trans. AGU, 86(18), Fall Meet. Suppl., Abstract G23A-03, 2005.
10. Bieler, B.M, R. Garcia-Martinez, F. Miralles-Wilhelm, and S. Wdowinski, Modeling Water Flow in the Everglades Wetlands Using Interferometric Synthetic Aperture Radar (InSAR)Observations, Eos Trans. AGU, 86(18), Fall Meet. Suppl., Abstract G23A-05, 2005.
11. Kim, S, A. Ferretti, F. Novali, S. Wdowinski, F. Amelung, T.H. Dixon, R.K. Dokka, and B. Rabus, Observation of Subsidence in New Orleans Using Permanent Scatterers, Eos Trans. AGU, 86(18), Fall Meet. Suppl., Abstract G43A-04, 2005.

Space-based monitoring of wetland surface flow

PI: Dr. Shimon Wdowinski

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Significant finding of the project:

1. L-band InSAR of South Florida

Intereferometric processing of three JERS-1 L-band Synthetic Aperture Radar (SAR) data acquired over south Florida in June, August, and December 1994 reveal detectable surface changes in the Everglades wetlands and the Miami-Fort Lauderdale urban environments. The most noticeable surface changes occurred in the managed Water Conservation Areas in the northern section of the Everglades and moderate changes throughout the wetland environment, as well as in some urban locations. We attribute the observed phase changes to vertical changes of aquatic surface, because the tectonically stable carbonate platform of south Florida is unlikely to deform at the observed rates. Using stage data from the wetland area, we were able to confirm our assumption, as well as quantify the accuracy of the InSAR measurements in the range of 5-10 cm. The stage data also enable us to tie the relative InSAR measurements into an absolute reference frame and translate the observed water level changes into absolute water levels, reflecting dynamic water topography in response to hydraulic structure operations. InSAR detected surface changes in the urban area correlate with the location of main wellfields in the Miami-Dade and Broward counties. A comparison between the surface displacement over time and wellfield production rates suggests that surface displacement in the Northwest wellfield was induced by changes in production rate. However, the lack of correlation between production rates and deformation pattern in the Miami Springs wellfield requires a different displacement mechanism. We suggest that observed vertical motion in the Miami Springs and other urban areas was caused by flooding events due to heavy rains during and prior to the August data acquisition.

2. C-band InSAR

Although conventional wisdom suggests that C-band interferometry does not work in vegetated areas, we recently found, to our great surprise, that C-band interferograms with short acquisition intervals (1-105 days) can maintain excellent coherence over the Everglades wetlands. Our experimental study was part of an ESA CAT-1 proposal, where we used archived ERS-1/2 acquired over south Florida during the years1995-1998. Initial data processing shows superb interferometric coherence with the tandem mission (1-day interval between acquisitions) and variable coherence levels with the 1-3 repeated orbit cycles (35 days), depending on the acquisition time interval, baseline, and atmospheric conditions.

The immediate advantage in using C-band SAR data for detecting wetland water level changes is the availability of current data, due to two active C-band satellites – RADARSAT-1 and ENVISAT. We have ordered SAR data from both satellites in order to evaluate optimal acquisition parameters (view angel, polarization, and resolution) and access near-real time operation of InSAR based monitoring of water level changes. Our

analysis of the various data type shows that RADARSAT-1 data obtained with 24 day repeat cycle, HH-polarization, and fine beam (7 m pixel resolution) produce best interferograms.

3. Flow models

Following our successful C-band results, we started ordering RADARSAT-1 data in a systematic manner to monitor water level changes in the Everglades area. One of our focus area is Water Conservation Area 1 (WCA-1), which its unique hydrological conditions generate very interesting fringe patterns. Successive data acquisitions allowed us to produce an interferogram time series, showing the time progression of water level changes. This series of interferograms are now being used by a MS student, B.M. Bieler, to constrain a high spatial-resolution flow model of WCA-1.

Information Transfer Program

During FY 2004, the Florida WRRC actively promoted the transfer of 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. Researchers can either check out copies of these reports, or purchase copies for a nominal fee to cover the cost of reproduction and mailing. As newer reports become available, electronic versions of these reports are being 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 was the Principal Investigator for the Information Transfer task.

Information Transfer

Basic Information

Title:	Information Transfer
Project Number:	2004FL130B
Start Date:	3/1/2004
End Date:	4/28/2005
Funding Source:	104B
Congressional District:	6
Research Category:	Not Applicable
Focus Category:	None, None, None
Descriptors:	
Principal Investigators:	Louis H. Motz, Elizabeth Ryan

Publication

1. Tiruneh, N. D., Simulation and Optimization of Seawater Intrusion in Coastal Aquifers Due to Climate Change and Sea Level Rise, Ph.D. Dissertation, University of Florida, December, 2004.
2. Zhong, J., Two-Dimensional Analytical and Three-Dimensional Finite-Element Modeling of the Interactions Between Wetlands and Groundwater, Ph.D. Dissertation, Unversity of Florida, December, 2004.
3. Motz, L. H. 2004. Representing the Saltwater-Freshwater Interface in Regional Groundwater Flow Models. 18th Salt Water Intrusion Meeting, SWIM 2004, Cartegena, Spain, May 31 - June 2, 2004.
4. Agyei, E. and K. Hatfield. 2004. "Enhancing gradient-based parameter estimation with an evolutionary approach." Journal of Hydrology (Accepted).
5. Perminova, I.V., A.N. Kovalenko, P. Schmitt-Kopplin, N. Hertkorn, E.Y. Belyaeva, K. Hatfield, V.S. Petrosyan. 2005. "Design of quinoid-enriched humic materials with enhanced redox properties," Environmental Science and Technology (In Review).
6. Sedighi, A., H. Klammler, C. Brown, and K. Hatfield, 2005. "A semi-analytical model for predicting water quality from an aquifer storage recovery system," J. of Hydrology (In Review).
7. Newman, M., K. Hatfield, J. Hayworth, P.S.C. Rao, and T. Stauffer. 2005. A hybrid method for inverse characterization of subsurface contaminant flux. Journal of Contaminant Hydrology. In Press.

Student Support

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

Notable Awards and Achievements

None

Publications from Prior Projects