UNIVERSITY GRADUATE SCHOOL BULLETIN
ANNOUNCEMENT

Florida International University
University Graduate School

Doctoral Dissertation Defense

Abstract

Integrated Surface-Ground Water Modeling in Wetlands with Improved Methods
to Simulate Vegetative Resistance to Flow

by

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In topographically flat wetlands, there is a very shallow water table and a highly conductive soil, and the connection between surface water and groundwater is not only present, but perhaps the key factor dominating the magnitude and direction of water flux. Due to their complex characteristics, modeling these areas using more realistic process formulations (integrated surface-ground water and vegetative resistance) is an actual necessity.

This dissertation focuses on developing an integrated surface – subsurface hydrologic simulation numerical model by programming, testing and coupling of the USGS MODFLOW-2005 Groundwater Flow Process (GWF) package (USGS, 2005) with the 2D surface water routing model: FLO-2D (O'Brien et al., 1993). The coupling includes the necessary procedures to integrate both models as a single computational software system that will be called WHIMFLO-2D (Wetlands Hydrology Integrated Model). An improved physical formulation of flow resistance though vegetation in shallow waters based on the concept of drag force was included for the simulations of floodplains, while the use of the classical methods (e.g., Manning, Chezy, Darcy-Weisbach) to calculate flow resistance will be maintained for the canals and deeper waters.

The application of the developed model was performed in an existing field site using data from the Loxahatchee Impoundment Landscape Assessment (LILA), an 80 acre area located at the Arthur R. Marshall Loxahatchee National Wild Life Refuge in Boynton Beach, Florida. Results showed the capacity of the model to simulate the hydrology of a wetland. Comparison between measured and simulated stages level showed an average error of 0.31% with a maximum error of 2.8% for the calibration and an average error of 0.20% and a maximum error of 0.77% for the validation. Comparison of measured and simulated groundwater head levels showed an average error of 0.18% with a maximum of 2.9%.

The model simulation results show that the coupled model is capable to simulate the complex coupled hydrology of wetlands. The coupling of FLO-2D model with MODFLOW 2005 model and the incorporation of the dynamic effect of flow resistance due to vegetation performed in the new modeling tool WHIMFLO-2D is an important contribution to the field of numerical modeling of hydrologic flow in wetlands.

Date: November 4, 2009
Time: 10:00 a.m.
Place: Engineering Center, EC 3626

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