

Applications of a Numerical Model for Simulation of Flow and Transport in Connected Freshwater-Wetland and Coastal-Marine Ecosystems of the Southern Everglades

Raymond W. Schaffranek, Harry L. Jenter and Ami L. Riscassi

U.S. Geological Survey, National Center, Reston, VA

Christian D. Langevin, Eric D. Swain and Melinda Wolfert

U.S. Geological Survey, Center for Water and Restoration Studies, Miami, FL

Water-management agencies responsible for implementing the Comprehensive Everglades Restoration Plan (CERP) need to insure that hydrologic conditions are maintained in land-margin ecosystems of Everglades National Park (ENP) that satisfy habitat requirements of endangered freshwater and estuarine species. The U.S. Geological Survey has developed a hydrodynamic/transport model uniquely suited to simulate flow and salt flux through these coupled surface- and ground-water ecosystems. A numerical algorithm was developed to synchronize surface-water tidal-compatible time steps with ground-water stress periods and to assure mass conservation of simulated flux quantities across the surface-/ground-water interface and land-surface boundary in the model (Swain and others, 2002). Hydraulic expressions, derived from hydrologic process studies in the Everglades, have been formulated to link flow resistance (Lee and others, 2002), wind stress (Jenter and Duff, 1999), and evapotranspiration processes (German, 2000) to vegetation properties and shallow flows typical of these low-gradient wetlands.

Two applications of the coupled model have been made that are largely within the confines of ENP (fig. 1). The Southern Inland and Coastal Systems (SICS) model encompasses the Taylor Slough wetlands, part of the C-111 drainage basin, and sub-tidal embayments along the northern coastline of Florida Bay. The Tides and Inflows in the Mangrove Ecotone (TIME) model encompasses the SICS model domain, Shark River Slough, other western sloughs, and sub-tidal embayments and tidal creeks along the southwest Gulf coast. Measured surface-water flow discharges, water levels, and salt concentrations at tidal creeks (fig. 1) (Hittle and others, 2001); wetland water levels and flow velocities (Tillis, 2001; Riscassi and Schaffranek, 2002); and ground-water heads and salinities (Price, 2001) supplemented by sub-surface salinity maps (Fitterman and Deszcz-Pan, 1998) and peat thickness and hydraulic gradients (Harvey and others, 2000) were used for model calibration and verification. Tide levels and salt concentrations along the coast and discharges and water levels at hydraulic structures (fig. 1) and road culverts constitute the data used to drive the SICS and TIME simulations.

Flow exchanges between the surface- and ground-water systems simulated by the SICS model are presented in figure 2 to demonstrate its capability and illustrate typical model output. Positive exchanges, expressed as averages in cm/day for the 5-year simulation, indicate areas of recharge to the aquifer and negative values indicate areas of discharge to the wetlands. Similar output is available that identifies salt fluxes between the surface- and ground-water systems. Model output such as this is needed to fully evaluate the potential impact of restoration decisions for the greater Everglades on coastal land-margin ecosystems of ENP.

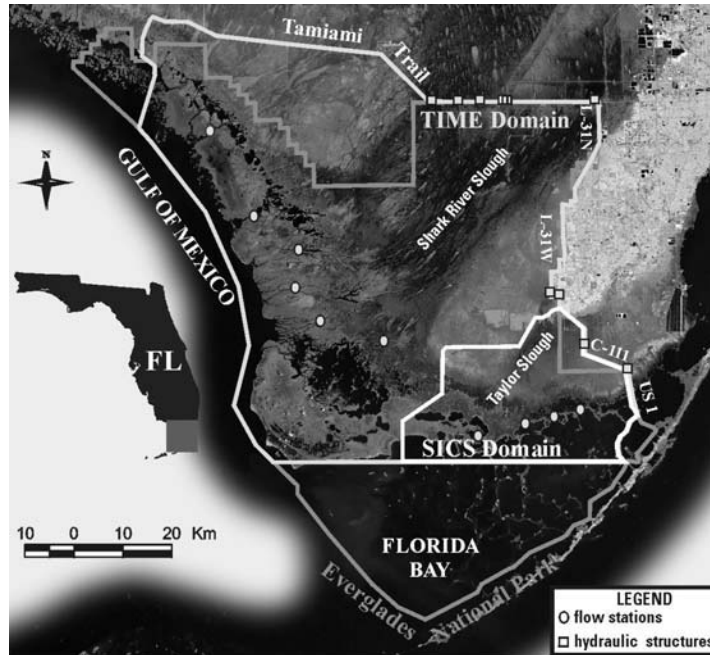


Figure 1. South Florida satellite image showing SICS and TIME model domains.

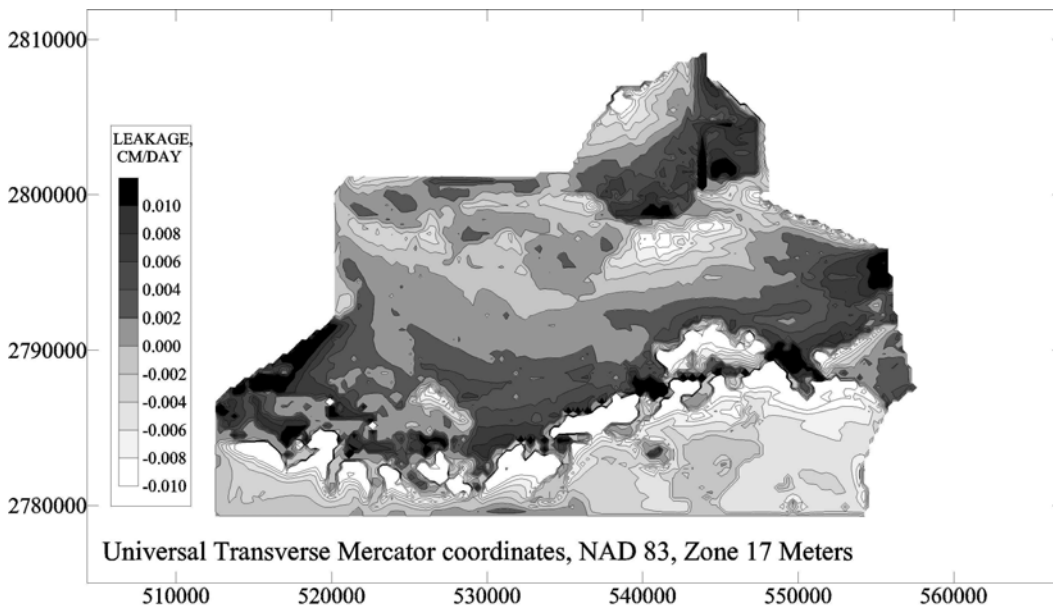


Figure 2. SICS model output showing surface-/ground-water exchange.

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Contact Information: Raymond W. Schaffranek, U.S. Geological Survey, National Center MS 430, Reston, VA, 20192, Ph: 703-648-5891, Fax: 703-648-5484, Email: rws@usgs.gov