Modeling at SFWMD

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Modeling at the District

- Hydrologic & Environmental Systems Modeling Department
  - Centralized Model Development
  - Regional Modeling (Development, Implementation, Application)

- Other Departments
  - Model Implementation & Application
Complexities of the South Florida System

- St. Lucie Basin
- Indian-Prairie \ Lake Shore Perimeter
- Seminole Brighton Reservation
- Caloosahatchee Basin
- Caloosahatchee Estuary
- Lower West Coast Basin
- Kissimmee River Basin
- St. Lucie Estuary
- Loxahatchee Estuary
- Big Cypress Seminole Reservation
- Miccosuhee Reservation
- Water Conservation Areas
- Service Area - 1
- Service Area - 2
- Service Area - 3
- ENP/Florida Bay
- Biscayne Bay
- Enron Water & Power Project/SMC
Decade of the 70s

- Electric Analog Model
  - Simulated water levels and flows in coastal region
- Upgraded Regional Routing Model to include daily time step
- Initial development of SFWMM (2x2)- a regional-scale computer simulation model
Physical Modeling - Real system
Physical Model at U.C. Berkeley
The SFWMM or 2X2

- Divides South Florida into 2 mile by 2 mile square grid cells
- Integrated surface water groundwater model
- Simulates:
  - Hydrology
  - Water Management
What is NSM?

- A computer model of the pre-drainage system
- Integrated surface and ground water hydrologic model
- 2,382 2 mile x 2 mile grid cells
- Lake Istokpoga to Florida Bay
Modeling Approach

SFWMM Model

Scenario

Model Output
- Daily time series of water levels, flows
- Demands not met

Performance Measures (Ag, Env, Urban)

• Landuse/Landcover
• Water Demands
• Operating Criteria

Modeling Approach

• Climatic Input
  – Rainfall
  – ET
• Boundary Conditions

Period of record: 1965-2000
RESTUDY PROCESS

INITIAL SCREENING

ALTERNATIVE FORMULATION

ALTERNATIVE DESIGN

MODELING OF ALTERNATIVES

WEB PUBLISHING OF ALTERNATIVES

EVALUATION OF ALTERNATIVES

SELECT PREFERRED ALTERNATIVE

PUBLIC COMMENT AND FEEDBACK

HYDROLOGIC MODELERS

ALTERNATIVE DESIGN TEAM

RESTUDY TEAM

WEB TEAM

ALTERNATIVE EVALUATION TEAM

Multi-Agency

US Army Corps of Engineers

USDA

USGS

Inter-Disciplinary

Zoologists

Public Affairs Specialists

Hydrogeologists

Engineers

Real Estate Specialist

Resource Managers

Planners

Environmental Scientists
Hydrologic Performance Measures

www.sfwmd.gov/org/pld/restudy/hpm
Decade of the 90s—Initial Development of RSM

- Development of the next generation models initiated:
  - Object-Oriented
  - C++
  - Database interfaces
  - New modeling algorithms researched
Water Resources Plans are becoming increasingly complex!
Classification of Models

- Hydrologic/Hydrodynamic
- Water Quality
- Ecological

Complexity & Data Necessary

Predictive Uncertainty
MODEL PROCESSES AND AREAS OF CONCERN

LEGEND:
- Green: Good
- Yellow: Needs attention
- Red: Needs a lot of attention

- Approval & Model Oversight
- Science - in Development
- Application Development
- Model Application
- Data Pre-Processing
- End Users
- Data Post-Processing
- Information Technology and GIS Support
Strategic Modeling Plan Implementation Progress

- Established the Office of Modeling (now HESM)
  - Model Development
  - Interagency Modeling Center (CERP)
  - Model Application (non-CERP)
- Established Modeling Oversight Team (MOT)
- Quality Assurance & Quality Control through implementation of a Modeling Methodology
  - Capability Maturity Model (CMM)
Peer Review

- A requirement of the new modeling methodology

- Status of peer reviews:
  - 2x2 model (1998, 2005)
  - RSM (Theory part reviewed in 2005)
  - LECsR (June 2006)
  - Everglades Landscape Model (ELM) (process initiated)
Regional Simulation Model (RSM)

- **Why we needed it?**
  - 2x2 has served for about 25-years. Need a next generation regional-scale model

- **Next generation tool needs to:**
  - Minimize or eliminate “single person dependency”
  - Be well documented, easy to learn, flexible and transparent
  - Defensible. Meet requirements of additional scrutiny that we did not have 10-15 years ago → Peer Review
  - Make use of new data, new technologies in computers and modeling methods.
  - Be efficient (reasonable run times), and accurate
RSM Development Approach

- Important tool for implementation of CERP and non-CERP projects
- Low-level effort used to design and begin the development of the next generation version of 2x2
- Higher priority on RSM during last two years - allocation of experienced 2x2 modelers in the development, contractual help
- A phased approach for completion
- Transition from 2x2 to RSM cannot happen overnight (due to unique differences)
RSM Versions

Natural System, NSRSM

Managed System, SFRSM

Surface exaggerated vertically for display
RSM Concepts

Hydrologic Simulation Engine (HSE)

- Simulates hydrologic processes
- Overland flow
- Groundwater flow
- Canal network
- Calibration/validation of model parameters

Management Simulation Engine (MSE)

- Simulate structure operations
- Implementation of operational rules
- Flood control rules
- Water supply policies
- Regional operational coordination

SFRSM
Natural System RSM

- Pre-drainage physical setup
- Simulate hydrologic processes
- Overland flow
- Groundwater flow
- River network
- Validation against pre-drainage historical records & anecdotal information
RSM Achievements to Date

- Several applications during development and implementation
- Numerous refereed journal articles (peer review)
- External Peer review of RSM theory (by a panel)
- Calibrated sub-regional models for Everglades Agricultural Area, Palm Beach, Broward, Miami-Dade, Caloosahatchee and St. Lucie
- Natural System Regional Simulation Model (NSRSM)
## Schedule - Phases

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<tr>
<th>FY05</th>
<th>FY06</th>
<th>FY07</th>
<th>FY08</th>
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<tbody>
<tr>
<td>RSM Phase I</td>
<td>RSM Phase II</td>
<td>RSM Phase III</td>
<td>RSM Phase IV</td>
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<tr>
<td>• Hydrologic simulation calibration &amp; validation</td>
<td>• Address peer review recommendations</td>
<td>• Apply subregional SFRSMs and NSRSM in selected projects</td>
<td>• Apply SFRSM for priority Program needs</td>
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<td>• Peer Review – RSM Theory</td>
<td>• Develop coupling of hydrology &amp; water management</td>
<td>• Peer Review of Natural System RSM</td>
<td>• Continue migration from 2x2 to RSM</td>
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<td>• Natural System RSM initial version</td>
<td>• Develop selected subregional models (eg. Miami-Dade)</td>
<td>• Complete management capabilities</td>
<td>• Finalize Water Quality features</td>
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<tr>
<td></td>
<td>• Initial Water Quality Development</td>
<td>• Start migration from 2x2 to RSM</td>
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<td>• Enhance Water Quality features</td>
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Conceptual Model and Grid Design

- Covers the entire lower east coast region
- Three (3) model layers to account for heterogeneity in the surficial aquifer
- Spatial and temporal scales
  - Cells (704 ft. by 704 ft.) – 225 cells in each 2x2 cell
  - Daily time step
Lower East Coast SubRegional (LECsR) Model Overview

- Combines previous county-level models
- Three dimensional groundwater flow model of Surficial Aquifer System
- Based on the popular groundwater model developed by USGS (MODFLOW)
- Includes SFWMD developed enhancements
- Integrates surface water in wetlands
- Effect of system-wide operations to be obtained from 2x2 and RSM (in the future)
- Peer Review – complete June 2006
Lake Okeechobee

- Largest lake in southeastern US
- Area: 1730 km²
- Average depth: 2.7 m
- Surrounded by dike
- Turbid, wind driven
- Eutrophic
A Diagram of Major Processes in the LOEM
Restoration of the Loxahatchee River
Modeling Tool Development for the Northwest Fork Restoration

Watershed Model: WaSh

Long-Term Daily Freshwater Flow

2-D Estuarine Hydrodynamic and Salinity Model: RMA

Long-Term Salinity Management Model: LSMM

Evaluation of Ecosystem Restoration Alternatives

Long-Term Daily Salinity
Loxahatchee River Salinity Model Domain
Integrate hydrology, biology and nutrient cycling in spatially explicit simulation

Understand ecosystem dynamics at regional scale

Develop predictions of landscape response to altered water & nutrient management
Thank You!

Questions?
Development History of the Lake Okeechobee Hydrodynamic and Wind-wave Model

- Wind-wave Model (by wind-wave equations approach)

- Wind-wave Model (by Spectral Energy Approach)

- 3-D Hydrodynamic Model (modified from EFDC)

- 3-D Sediment Model (modified from EFDC)
CERP Components

Aquifer Storage & Recovery

Surface Water Storage Reservoir

Stormwater Treatment Areas (STAs)

Reuse Wastewater

Seepage Management

Removing Barriers to Sheetflow

Operational Changes

- 6 pilot projects
- 15 surface storage areas (~170,000 acres)
- 3 in-ground reservoirs (~11,000 acres)
- 19 stormwater treatment areas (~36,000 acres)
- 330 aquifer storage and recovery wells
- 2 wastewater reuse plants
- Removal of over 240 miles of canals, levees and structures
- Operational changes