Florida Water and Climate Alliance

- Increasing the relevance and usability of climate change and variability data and tools
- Understanding the context/situation
- Assessing tools
- Evaluating practical applicability
- Using the quantitative climate information for planning and decision making processes
Presentation Outline

- Broward County Models
  - Saltwater Intrusion
  - Climate/Inundation
- Model Development Update
- Model Applicability & Limitations
- Climate Change Variables
- Focal Area Discussion
  - Areas of Concern
  - Adaptive Strategies
Background

- Coastal Aquifer

- Anthropogenic Stresses:
  - Everglades drainage
  - Well field pumping
  - Canal water level management
  - Agricultural/Urban development

- Natural Stresses:
  - Sea level rise
  - Rainfall variations
Broward Modeling Development

WHY?
To address saltwater intrusion, climate variability and Sea Level Rise—needed integration of density-dependent model components.

Collaboration with USGS/Local Gov’t developed fully-integrated surface-water and groundwater model using MODFLOW based tools combined with:

- Unique surface-water process
- Density dependent flow

- Outputs include the impacts of SLR on GW elevations, flood management operations and water quality in support of water supply operations
Variable Density Model

- Use the historical data record to calibrate aquifer flow and transport parameters
- Conduct a sensitivity analysis to determine
  - Data most useful for calibrating
  - Model parameters of most influence
- Quantify the relative importance of various hydrologic mechanisms
- Perform predictive scenarios
Model Extents
Variable Density Models-STATUS

Completed
- Hydrostratigraphic Framework
- Data collection (Water level & Chloride)

In Progress
- Establishing historical land use from aerial photos
- Filling in data gaps
- Thiessen polygons for rain data
- Canal system with structural operations

Future Tasks
- Calibration and sensitivity analysis
- Quantification of hydrologic mechanisms
- Predictive scenario testing
Sensitivity - Well Field Withdrawals
Movement of 250 mg/L Salt Front with Varying Sea Level Rise Estimates
Climate/Inundation Model

- 3 year project that implements recommendations of Broward County CCTF

- Use of numerical models to assess the potential effects of climate and sea-level change on current surface water management and drainage systems

- Development of integrated surface water/groundwater flow and transport models of 2 representative areas of Broward County

- Provide for better understanding of how climate change and sea level rise:
  - May affect current surface water management practices
  - how adverse effects can be mitigated
Tidal Flooding 9/18/09 – Las Olas

- Las Olas Isles
- Isle of Capri Drive
- Riverwalk

(8 inches above average high tide)
Storm Events

9.5” in Northern Broward County

16.2” in Southern Broward County
Storm Events
Development Updates
Domains & Structures

(a) Explanations:
- PILOT STUDY AREA
- GRID INSET AREA
- PRIMARY STRUCTURE
- SECONDARY STRUCTURE

Hydrography:
- PRIMARY
- SECONDARY
- NORTHERN DOMAIN
- CENTRAL DOMAIN
- SOUTHERN DOMAIN

(b) Inland:
- Davie

(c) Coastal:
- Fort Lauderdale
- Port Everglades
- Airport
Grids

Explaination

- Inundation grid (50m x 50m)
- Saltwater Inursion grid (500' x 500')
Additional Inundation Detail

- More robust representation of structures
Additional Inundation Detail

- More hydrology

Primary & Secondary Canals In Saltwater Intrusion Models

Tertiary Canals That May Be Added for Inundation Models
Additional Inundation Detail

- More hydrologic processes
  - Urban Runoff (URO) Processes
Climate Change Variables
Sea Level Rise

- Future scenarios will also incorporate various predictions of sea level rise (SLR)
- Predicted SLR in 2100 ranges from 8 to 60 inches
- SLR can lead to reduced capacity of coastal structures and ability to drain water to the coast
- Additional complications from SLR arise from storm events and high-high tide events
- SLR estimates produced using U.S. Army Corps of Engineers guidelines as used in Climate Change Compact documentation.

From “A Unified Sea Level Rise Projection for Southeast Florida” by Southeast Florida Regional Climate Change Compact Counties
### Sea-Leve Rise Prediction (USACE method)

<table>
<thead>
<tr>
<th>Year</th>
<th>Current Rate</th>
<th>NRC Curve 1</th>
<th>NRC Curve 2</th>
<th>NRC Curve 3</th>
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<td>7.937</td>
<td>20.036</td>
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</table>
Downscaled GCM Results

- Global Climate Model (GCM) Results
- Large spatial discretization
- Many have poor representation of FL, mixed land and water cells
- Significant errors at finer temporal and spatial resolutions

Dynamically Downscaled GCM Results

- Center for Ocean-Atmospheric Studies (COAPS)
- Regional Climate Model (RCM) coupled to GCM
- 10 km grid resolution
- Uses FSU-FCI Regional Spectral Model
- Output has be utilized as hydrologic model inputs in other USGS studies
- May not fully represent localized climate accurately even at 10 km scale

Source: Stefanova et al., 2011
Development of Future Scenarios

Proposed Base & Future Scenarios for Inundation Project

A. Community Climate Systems Model (CCSM)
   - Baseline - 20th Century CCSM Precipitation, No SLR
   - Low SLR Prediction – 21st Century CCSM Precipitation, Low SLR Estimate
   - High SLR Prediction - 21st Century CCSM Precipitation, High SLR Estimate

B. Hadley Centre Coupled Model v3 (HadCM3)
   - Baseline – 20th Century HadCM3 Precipitation, No SLR
   - Low SLR Prediction – 21st Century HadCM3 Precipitation, Low SLR Estimate
   - High SLR Prediction – 21st Century HadCM3 Precipitation, High SLR Estimate

C. Geophysical Fluid Dynamics Laboratory (GFDL)
   - Baseline – 20th Century GFDL Precipitation, No SLR
   - Low SLR Prediction – 21st Century GFDL Precipitation, Low SLR Estimate
   - High SLR Prediction – 21st Century GFDL Precipitation, High SLR Estimate
Average of lunar high tide events over high tides for 2011 = 8-10 inches
Storms & weather patterns may push high tides > 24 inches
Design Storms

<table>
<thead>
<tr>
<th>Duration</th>
<th>Return Period (yr)</th>
<th>Broward Rainfall (in)</th>
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<tbody>
<tr>
<td>1 hr</td>
<td>5</td>
<td>3.2</td>
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<tr>
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<td>25</td>
<td>12-17</td>
</tr>
<tr>
<td>3 day</td>
<td>100</td>
<td>16-23</td>
</tr>
</tbody>
</table>
100 Year Storm - December 17-19, 2009

16.2" in Southern Broward County

1d/100yr = 12-18 in 15.52 in.

3d/100yr = 16-23 in 18.07 in.
10 Year Storm - October 29-31, 2011

1d/10yr = 7-11 in 6.24 in.
3d/10yr = 10-14 in 10.78 in.
Outputs

- Hydrographs
- Chlorides
- Maps of flooding extents:
  - Depth -> 6 inches
  - Duration -> 72 hours
Focal Area Discussion
BROWARD COUNTY SEA LEVEL RISE MAPPING: THREE-FOOT

LEGEND

- Pilot Study Area

System
- Primary Structure
- Secondary Structure
- Water Treatment Plants
- Wastewater Treatment Plants

Inundation
- Orange: Possible
- Magenta: More likely

Prepared By:
Broward County GIS
Planning and Redevelopment Division
Environmental Protection and Growth Management Dept.
Scenario Development- Saltwater Intrusion

General Assessments

- Sea level rise scenarios with seasonal changes in precipitation
- Impacts on wet season/dry season groundwater levels
- Changes in groundwater chlorides
- Develop and test adaptive scenarios

Potential Adaptive Scenarios

- Using current pumping rates with projected sea level rise to determine future viability of coastal well fields
- Drainage Wells for mitigating/managing coastal saltwater intrusion interface
- Movement of G-54 Structure eastward
- Deepening or construction of new canals west of wellfields to increase recharge
- Exploring relationship of rainfall and saltwater front movement
- Data worth analysis for optimizing saltwater monitoring network
Scenario Development - Climate/Inundation

General Assessments
- Degree of inundation in response to various SLR rates
- Design Storm Events
- High Tide Events
- Combinations of SLR, storms events, and high tide
- Assess impacts on inland and coastal groundwater and surface water levels
- Develop and test adaptation strategies

Potential Adaptive Scenarios
- Replacement of gravity drainage infrastructure with pumps
- Movement of control structures
- Retrofitting current control structures (adding or increasing pump capacity)
- Increasing coastal sea wall heights
Summary

- Regional water resource planning needed to coordinate:
  - Future water supply demands
  - Restricted use of Biscayne Aquifer
  - Reuse Requirements
  - Influences of climate change

- Various tools have been developed to help guide management decisions and water management strategies for:
  - Protection of current resources
  - Development of alternative water resources
  - Conservation to reduce demands

- This wide variety of integrated water resources projects will help decide prudent investments and long term sustainability
NEXT STEPS

- Building communication tools to translate complex modeling to decision makers
- Creating visual graphics and animations that capture modeling outputs at the streetview
- Incorporating economic analysis of impacted areas to provide for cost/benefits
- Guide the adaptation strategies needed for long-term planning and sustainability
Questions

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