Conservation Practices to Improve Groundwater Quality in Central Florida

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Golmar Golmohammadi, UF/IFAS RCREC

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Presentation Outline

- Introduction
- Objectives
- Groundwater modeling
- Model development
- Model calibration and validation
- Scenarios (alternative solutions)
- Future work

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Groundwater in Florida

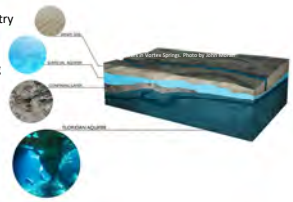
Importance of groundwater in Florida

- Groundwater is the principal source of freshwater for industry and agriculture, it supplies over 60 percent of the total freshwater used in Florida
- Groundwater in Florida supplies over 90 percent of drinking water for Floridians.

Features of Floridan's aquifer

- Karstic aquifers
- Sinkholes
- Underground caves
- Springs

Florida's geographical and climate characteristics:
- Sea level fluctuation
- Heavy rainfalls of Florida
- sandy soils
- Groundwater-surface water interactions



Florida's surface waters depend on groundwater contributions (Sinkholes; Spring fed streams, and lakes

Florida Department of Environmental Protection 2013

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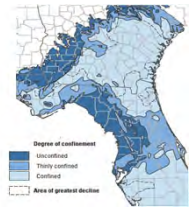
Groundwater Study

Groundwater Issues in Florida

- **Groundwater depletion**
- **Saline-related contamination issues**
- **Nutrient pollution**



Impacts of Nutrient Pollution

- **Nitrate contamination** in groundwater
  - Degraded springs ecology; risk to human health
  - **Eutrophication** of surface water; risks to aquatic plants and animals

- How to **prevent** and **control nutrients**?
  - Additional regulatory measures?
  - Agricultural BMPs/Urban LIDs
    - Stormwater treatment areas
    - Fertilizer management
    - Wetlands

Williams and Spechler, 2011; Provost et al, 2006; Konikow, 2013
http://pubs.usgs.gov/sir/2013/5079

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Groundwater Study

Goals and Plans

To provide a tool for simulating groundwater system; evaluating the effectiveness of existing and alternate BMPs in improving the water quality in Florida's cattle ranches and underlying aquifers

- Develop a numerical model to be able to simulate the groundwater system and predict how the system can be affected by changes in stresses
- Propose alternative BMP scenarios
- Prioritizing BMPs to enhance water quality

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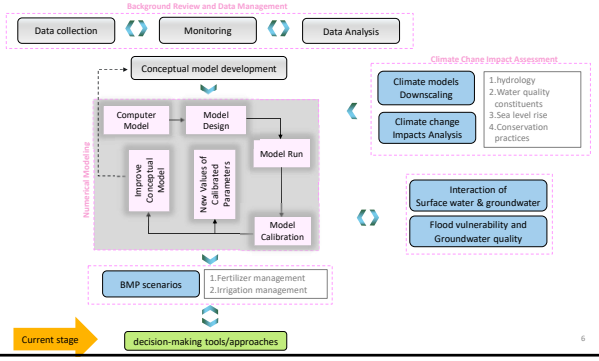
Groundwater modeling Study



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Groundwater Modeling Area

Site-scale model and **regional-scale** model

- to address potential adverse boundary conditions impacts.
- flexibility to extend the site-scale model beyond the current extent for new data

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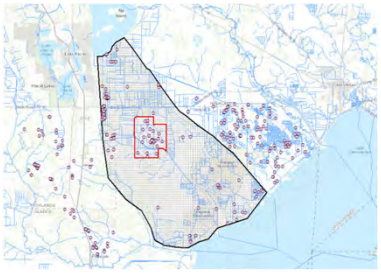
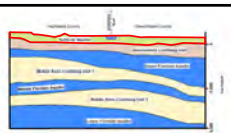
Conceptual Model

Conceptual models are simplified, high-level representations of the site/region to be modeled.





- Surficial Aquifer System (SAS)
- Intermediate Aquifer System/Intermediate Confining Unit (IAS/ICU)
- Floridian Aquifer System (FAS)

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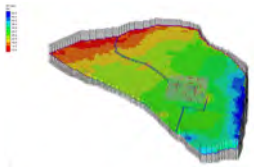
Groundwater Modeling

Model Inputs

- Topographic Data
  - Top Layer (Ground Surface)
  - Bottom Layer (Bottom of the Surficial Aquifer)
- Boundary Conditions
- Horizontal Hydraulic Conductivity
- Initial Head
- Inflow & Outflow Data



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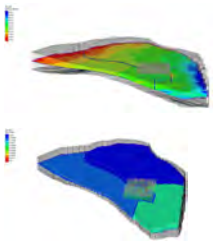
Groundwater Modeling

Model Inflow

- General Heads Boundary
- Rivers
- Recharge
  - Rainfall
  - Irrigation return flow

Model Outflow

- General Heads Boundary
- Well Exploitation (pumping)
- Evaporation
  - ET Rate at the surface
  - Extinction depth (10 ft)
- Drains (ditches)



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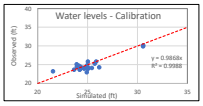
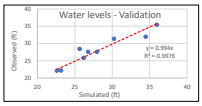
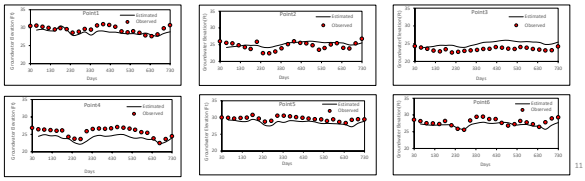
Model Calibration and Validation

Steady state model





Transient Model



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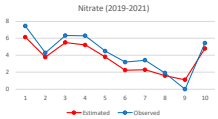
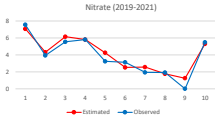
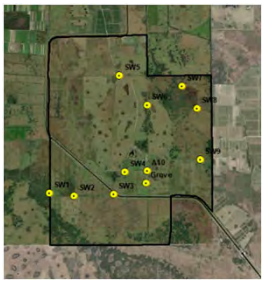
Model Calibration and Validation

Water Quality

Modular 3-Dimensional Transport model (MT3D) Model to simulate (verify) nitrate







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Scenarios

Fertilizer and Irrigation Management

1. During the months 1 to 9, fertilizer applied to existing condition fertilized ranches and irrigation scheme remains as current
2. During the Months 3 to 5, fertilizer applied to existing condition fertilized ranches and irrigation scheme remains as current
3. During the month 6 to 8, fertilizer applied to existing condition fertilized ranches and irrigation scheme remains as current
4. 20% reduction of fertilizer on Scenario 2
5. 50% reduction of fertilizer on Scenario 2
6. 20% reduction of irrigation on Scenario 2 (existing schedule 2019-2021)
7. Irrigation only in month 3 to 5 on Scenario 2 (same time with fertilizer application)
8. Irrigation only in month 3 to 5 on Scenario 3 (different time than fertilizer application)
9. No irrigation on Scenario 2
10. 30% reduction of irrigation Scenario 2

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Scenarios (Fertilizer Management)

Impact of timing of fertilizer application

1. **During the months 1 to 9, fertilizer applied to existing condition fertilized ranches and irrigation scheme remains as current**
2. **During the Months 3 to 5, fertilizer applied to existing condition fertilized ranches and irrigation scheme remains as current**
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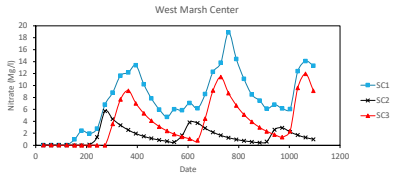

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Scenarios (Fertilizer Management)

Impact of rate of fertilizer application

1. During the months 1 to 9, fertilizer applied to existing condition fertilized ranches and irrigation scheme remains as current
2. **During the Months 3 to 5, fertilizer applied to existing condition fertilized ranches and irrigation scheme remains as current**
3. During the month 6 to 8, fertilizer applied to existing condition fertilized ranches and irrigation scheme remains as current
4. **20% reduction of fertilizer on Scenario 2**
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6. 20% reduction of irrigation on Scenario 2 (existing schedule 2019-2021)
7. Irrigation only in month 3 to 5 on Scenario 2 (same time with fertilizer application)
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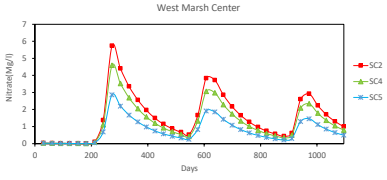

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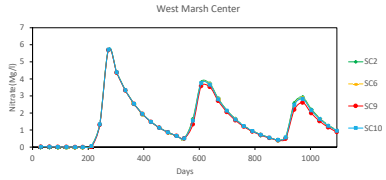
Scenarios (Irrigation Management)

Impact of rate of Irrigation

1. During the months 1 to 9, fertilizer applied to existing condition fertilized ranches and irrigation scheme remains as current
2. **During the Months 3 to 5, fertilizer applied to existing condition fertilized ranches and irrigation scheme remains as current**
3. During the month 6 to 8, fertilizer applied to existing condition fertilized ranches and irrigation scheme remains as current
4. 20% reduction of fertilizer on Scenario 2
5. 50% reduction of fertilizer on Scenario 2
6. **20% reduction of irrigation on Scenario 2 (existing schedule 2019-2021)**
7. Irrigation only in month 3 to 5 on Scenario 2 (same time with fertilizer application)
8. Irrigation only in month 3 to 5 on Scenario 3 (different time than fertilizer application)
9. **No irrigation on Scenario 2**
10. **30% reduction of irrigation Scenario 2**



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Future Work

Develop more scenarios

- More scenarios to be developed, based on the information from stakeholders (survey)
- Analytic Hierarchy Process (AHP)

BMP Selection and Implementation

To select the best strategy; a multi-criteria decision making (MCDM) model will be used

Scenario	1 Fertilizer location change	2 Fertilizer rate decrease	3 Fertilizer time change	4 Irrigation rate decrease	5 Irrigation time change
1 Fertilizer location change	1				
2 Fertilizer rate decrease		1			
3 Fertilizer time change			1		
4 Irrigation rate decrease				1	
5 Irrigation time change					1

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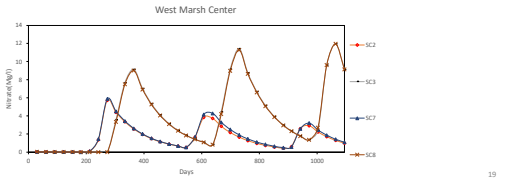
Scenarios (Fertilizer & Irrigation Management)

Impact of timing of fertilizer & irrigation

1. Month 1 to 9 fertilizer at fertilized ranches and existing irrigation scheme
2. **Month 3 to 5 fertilizer at fertilized ranches and existing irrigation scheme**
3. **Month 6 to 8 fertilizer at fertilized ranches and existing irrigation scheme**
4. 80% of fertilizer on Scenario 2
5. 50% of fertilizer on Scenario 2
6. 20% reduction of irrigation on Scenario 2 and existing irrigation scheme
7. **Irrigation only in month 3 to 5 on Scenario 2**
8. **Irrigation only in month 3 to 5 on Scenario 3**
9. Elimination the irrigation
10. 30%reduction of irrigation Scenario 2 and existing fertilized scheme



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