Groundwater Quantity & Quality Modeling Updates

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Ona Highlight, 12/10/2024

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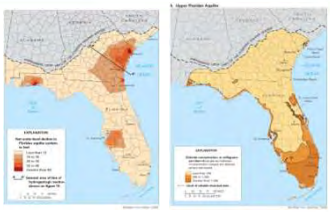
Groundwater in Florida

Features of Floridan's aquifer

- Karstic aquifer
- Sinkholes
- Underground caves
- Springs



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

FDEP 2020
http://pubs.usgs.gov/sir/2013/5079

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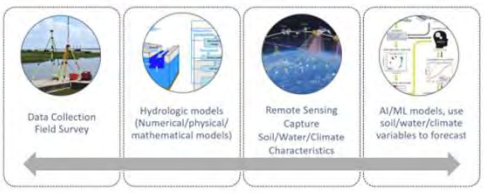
Hydrology & Water Quality Program, RCREC Ona



Biazar, S. M., Shehadeh, H. A., Ghorbani, M. A., Golmohammadi, G., Ghorbani, M. A., and A. Saha. "Soil Temperature Forecasting Using a Hybrid Artificial Neural Network in Florida Subtropical Grazinglands Agro-Ecosystems." Scientific reports 14.1 (2024): 1535–1535. Web.

Nemati, A., Golmohammadi, G., Javadi, S., Mohammadi, K., Rudra, R., Biazar, S. M., and Neshat, A. 2024. "Exceedance Probability Model for Predicting the Frequency of Summer Hot Day Patterns and Temperature Variability" STOTEN (accepted).

Golmohammadi, G., Nedhunuri, R. R.., and N. Tziolas. "Applications of Artificial Intelligence (AI) in Water Resources Forecasting". 2024. EDIS (Under Revision)

Golmohammadi, G., Nedhunuri, R. R. Biazar, S. M. Shaghaghi, S and K. Mohammadi. Large-scale forecasts of River Discharge and Groundwater Dynamics using Advanced AI models. 2024. STOTEN (Under Revision).

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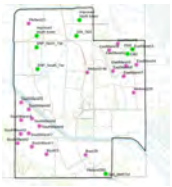
Instrumentation and data monitoring

- RCREC, Ona (instrumentation and data collection)
- DeLuca Preserve (instrumentation and data collection)
- BIR (available data, water quality data collection)

Study Area: BIR



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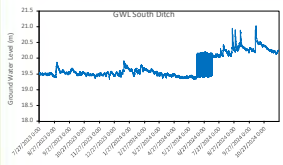
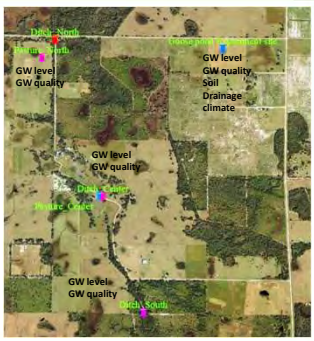
RCREC, Ona





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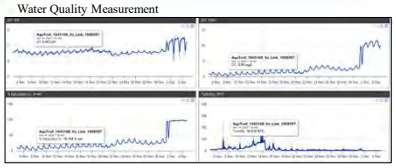
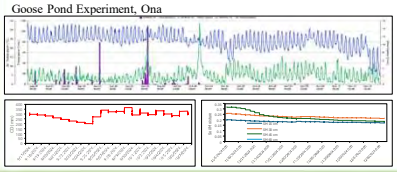
Water Quality Measurement



Goose Pond Experiment, Ona



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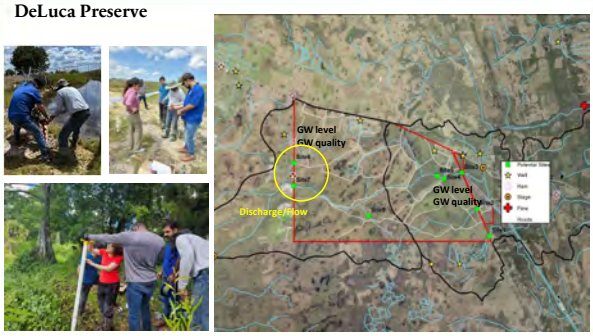
DeLuca Preserve



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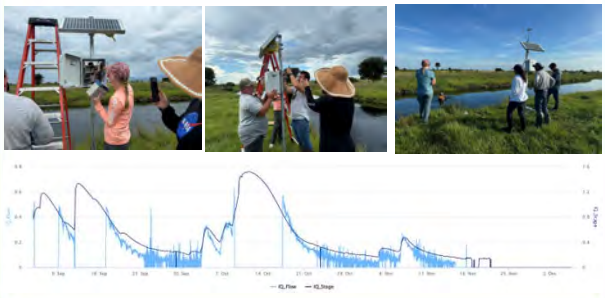
Flow Measurement at site 6, DeLuca Preserve



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Groundwater Modeling

Goals and Plans

To provide a tool for simulating groundwater systems; evaluating the effectiveness of existing and alternate BMPs in improving the water quantity and 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
- Develop various modeling techniques to forecast/simulate groundwater parameters

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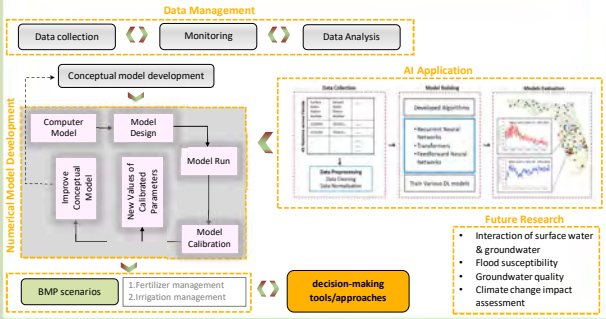
Groundwater Modeling Study



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Study 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

Archbold

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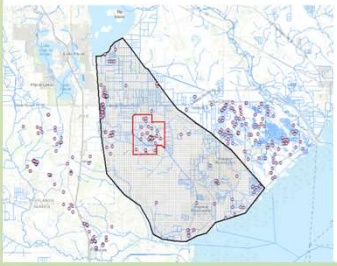
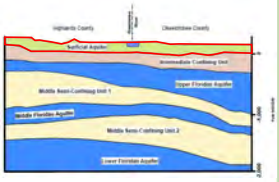
Conceptual Model

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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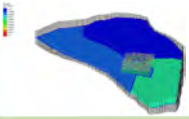
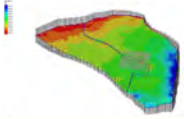
Groundwater Numerical Modeling

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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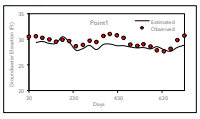
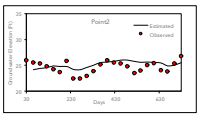
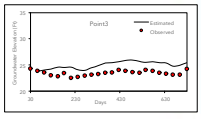
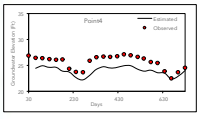
Model Calibration and Validation

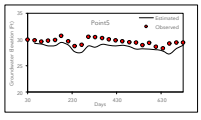
Groundwater Level

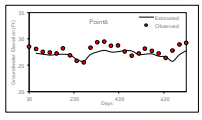












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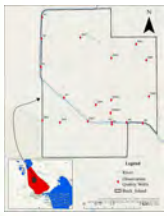
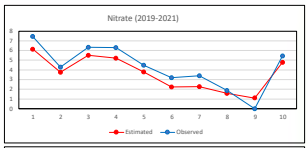
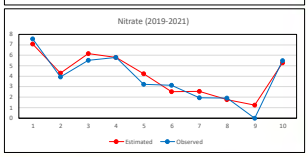
Model Calibration and Validation

Groundwater Quality (Nitrate)

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







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Scenarios

- **Scenario 1: During the months (March to May), fertilizer applied to existing condition fertilized pastures and irrigation scheme remains as current.**

Fertilizer Management

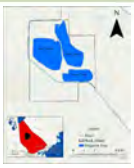
- **Scenario 2:** 20% reduction of fertilizer on Scenario 1.
- **Scenario 3:** 50% reduction of fertilizer on Scenario 1.
- **Scenario 4:** 100% reduction in fertilizer application in Scenario 1.

Irrigation Management

- **Scenario 5:** 20% reduction in irrigation rate in Scenario 1.
- **Scenario 6:** Irrigation only in months 3 to 5 in Scenario 1 (same time as fertilizer application)

Pasture Management

- **Scenario 7:** During Months 3 to 5, fertilizer is applied to existing fertilized pastures excluding three pastures with the highest impacts. The irrigation scheme remains as current



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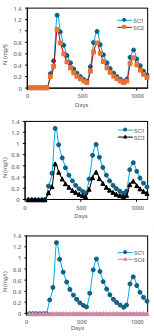
- **Scenario 5:** 20% reduction in irrigation rate in Scenario 1.
- **Scenario 6:** Irrigation only in months 3 to 5 in Scenario 2 (same time as fertilizer application)

Pasture Management

- **Scenario 7:** During Months 3 to 5, fertilizer is applied to existing fertilized pastures excluding three pastures with the highest impacts. The irrigation scheme remains as current



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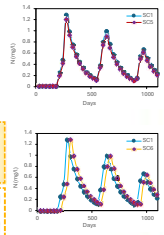

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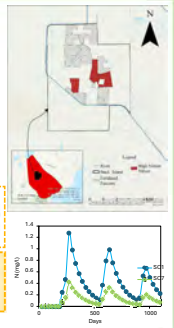

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Scenario Selection (Alternative Solutions)

Multi-Criteria Decision-Making Model (MCDM)

Alternative Scenarios → Analytic Hierarchy Process (AHP)

Social Economic Environment → Entropy Technique

→ EDAS Game Theory →

Scenarios	Rank
Fertilizer Rate Decrease	2
Irrigation Rate Decrease	3
Irrigation Time Change	4
Fertilizer Location Change	**1**

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Thank You!
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