

# Numerical Modeling of the effects of Hydrologic Conditions and Sediment Transport on Geomorphic Patterns in Wetlands



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PhD Candidate



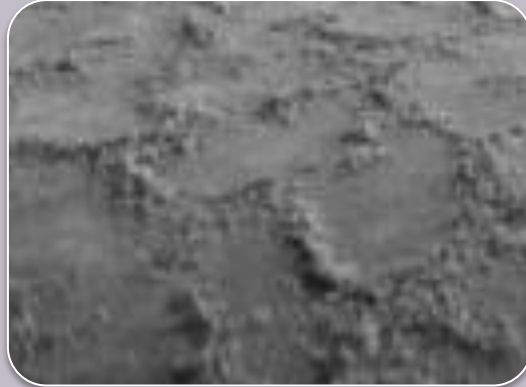
June 5th, 2012



# Wetland Landscape Patterning



Hammocks  
and  
hollows

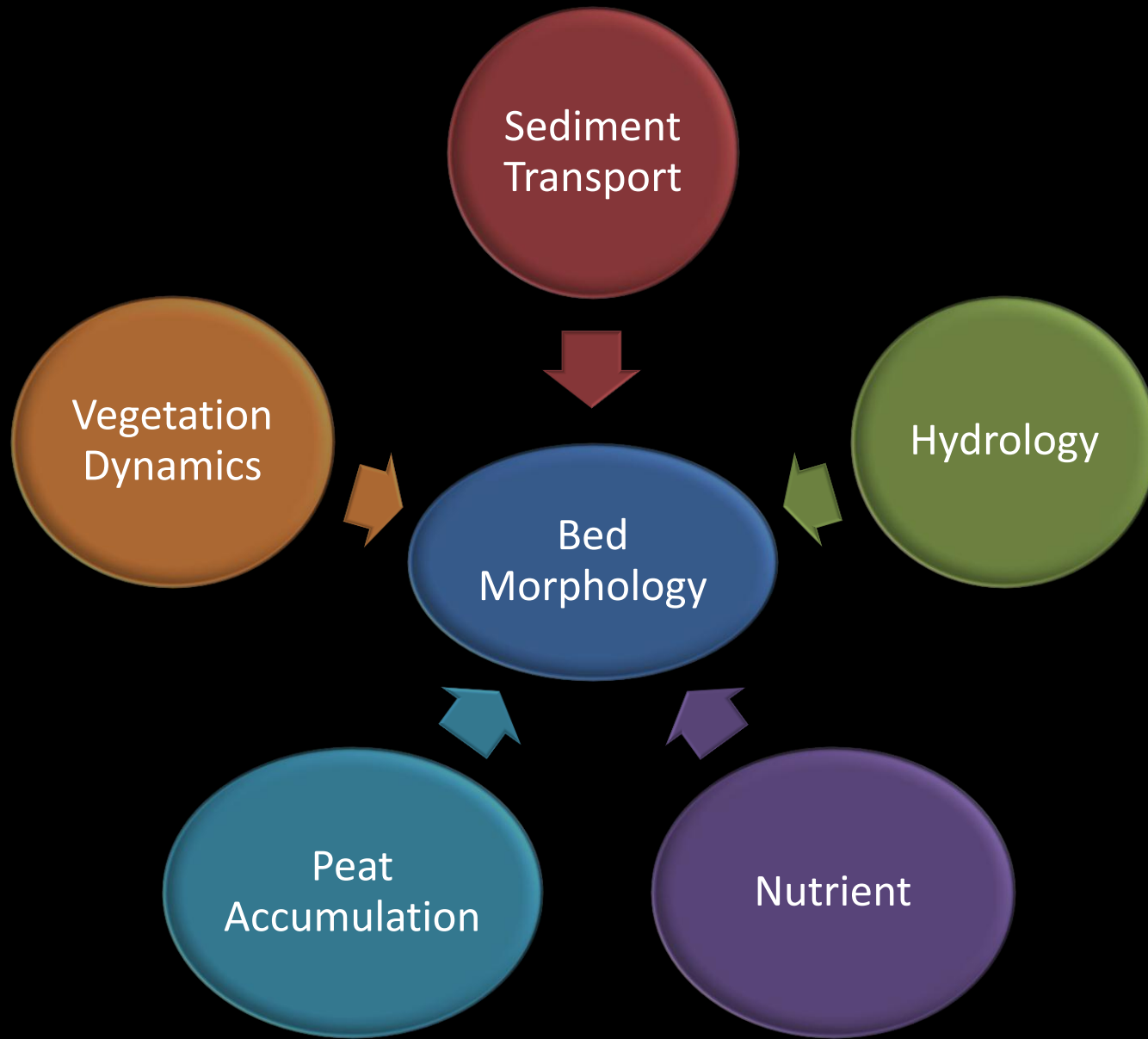


String and  
Maze  
patterning



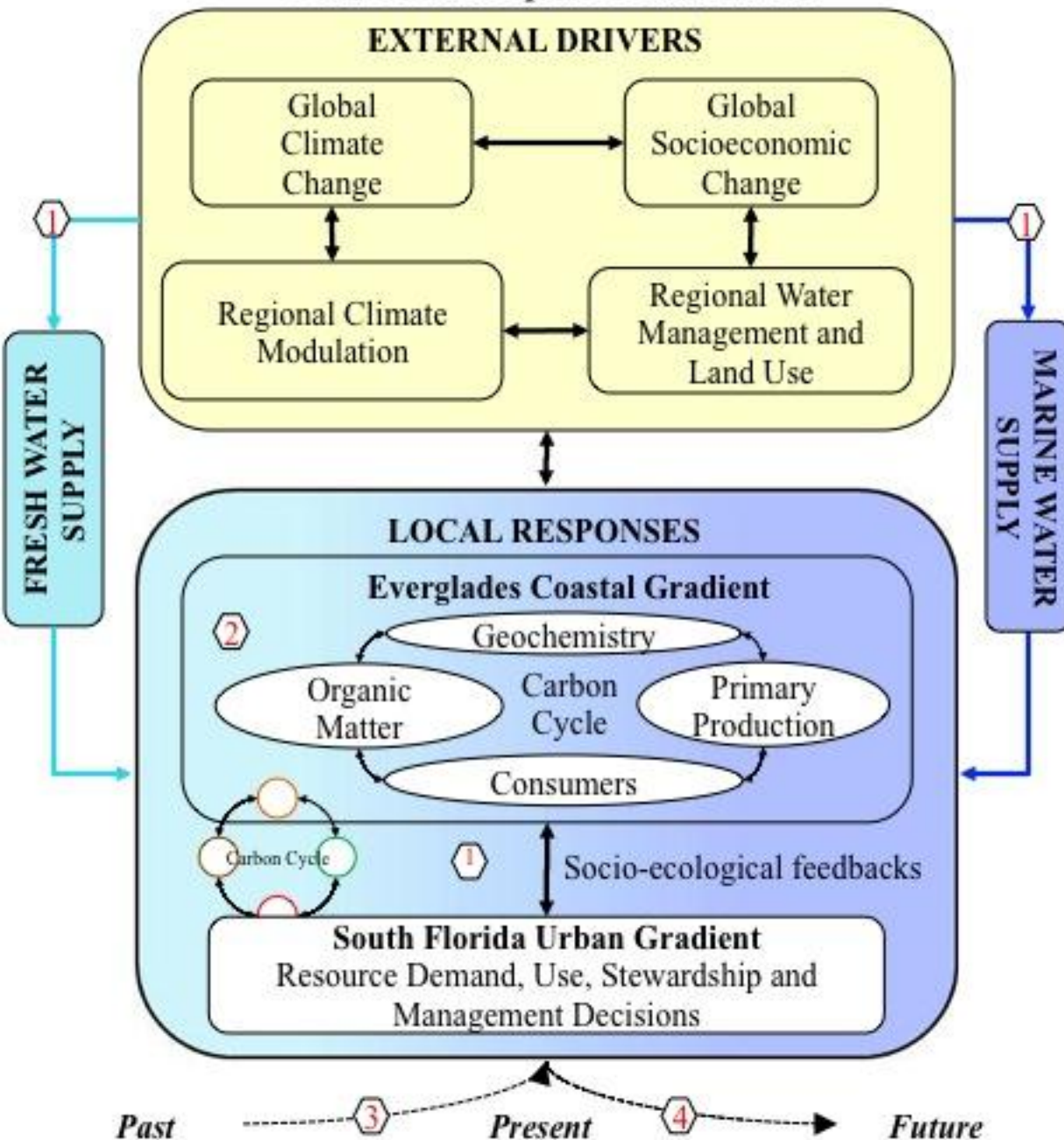
Ridge and  
Slough

# Mechanisms



# Multi-Scaled Socio-Ecology of the Everglades

## FCE III Conceptual Framework



## FCE III LTER Goals:

- Water:** How do water management decisions interact with climate change to determine freshwater distribution?
- Carbon:** How does the balance of fresh and marine water supplies regulate C uptake, storage, and fluxes by influencing water residence time, nutrient availability, and salinity?
- Legacies:** How does historic variability in the relative supply of fresh and marine water modify ecosystem sensitivity to further change?
- Scenarios:** What are alternative socio-ecological futures for South Florida under contrasting climate change and water management scenarios?

# Questions

Does sediment transport play a significant role on ridge and slough landscape evolution and maintenance in wetlands?

What are the effects of generated pulse flow in ridge and slough restoration?

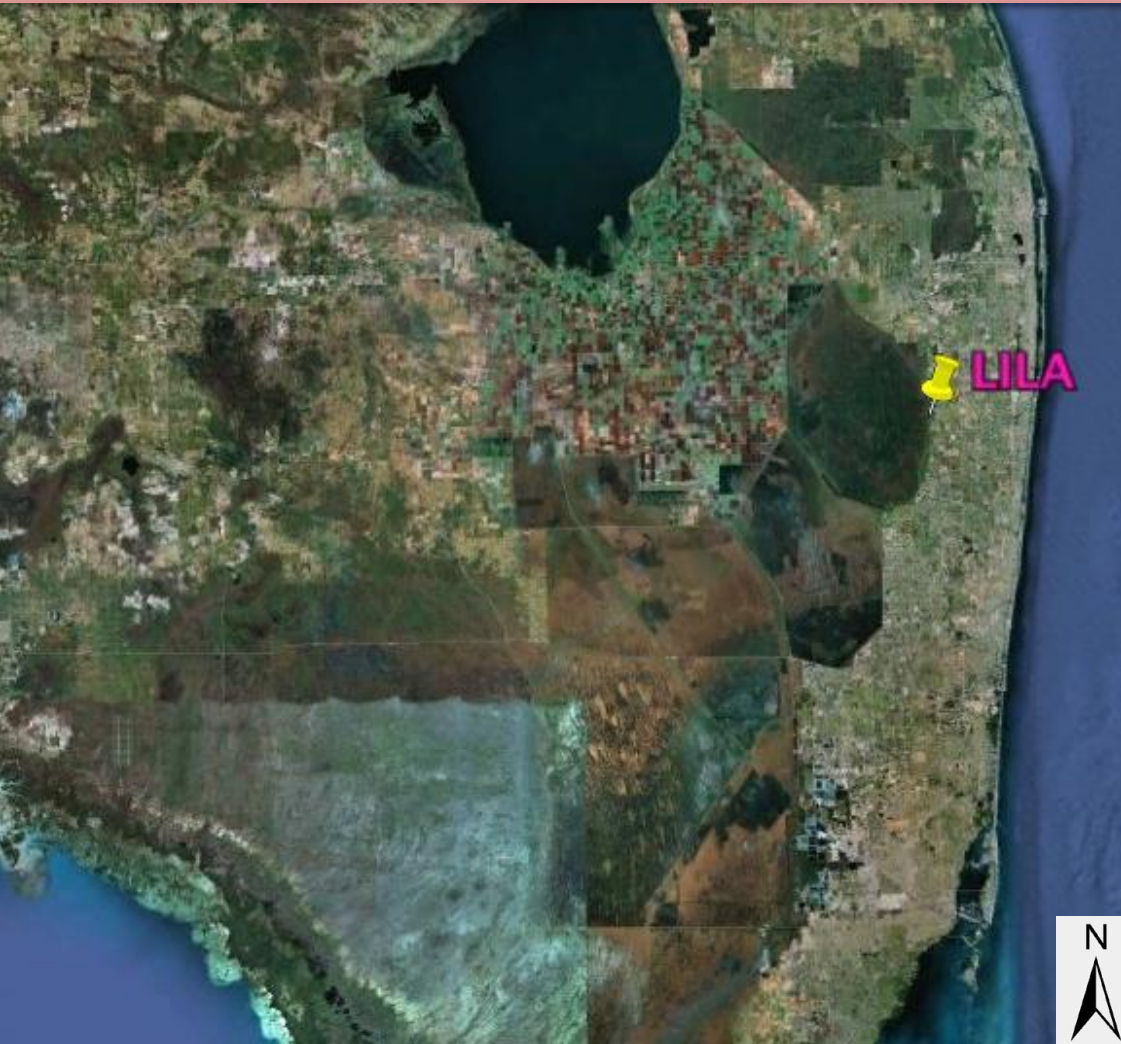
# Method

Development of the flow depth and velocity using FLO-2D

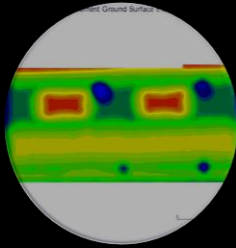
Development of a physically based numerical model of sediment transport and bed erosion



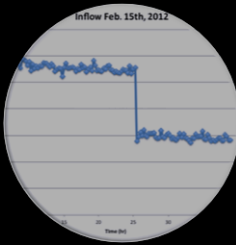
# Loxahatchee Impoundment Landscape Assessment (LILA)



# FLO-2D Simulation: Pulse Flow



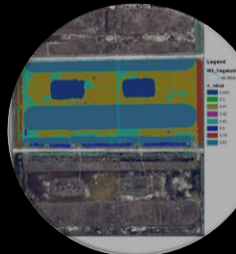
LiDAR data



Inflow hydrograph



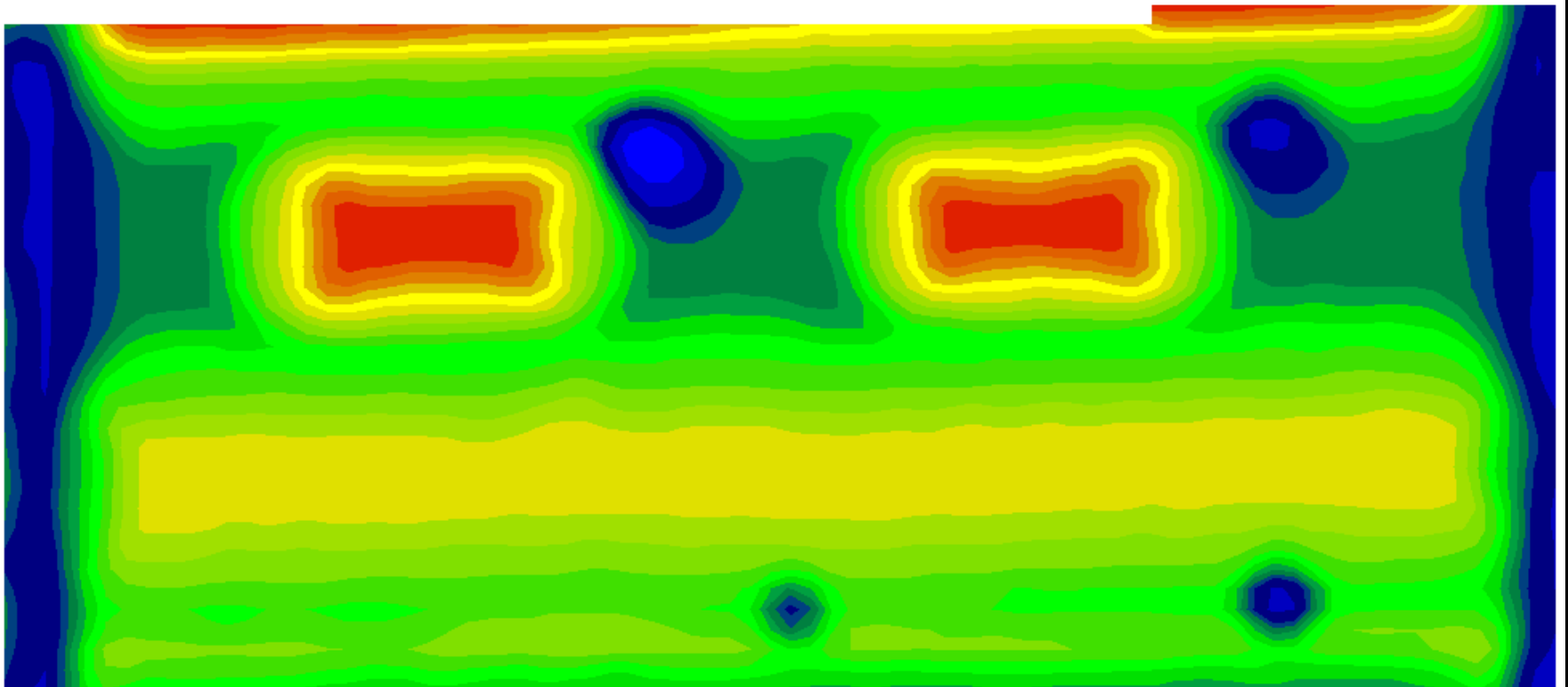
Outflow location



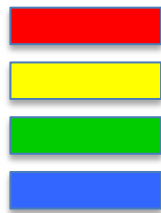
Vegetation Roughness



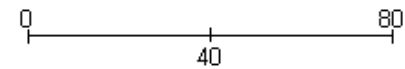
# Elevation (LiDAR Data)



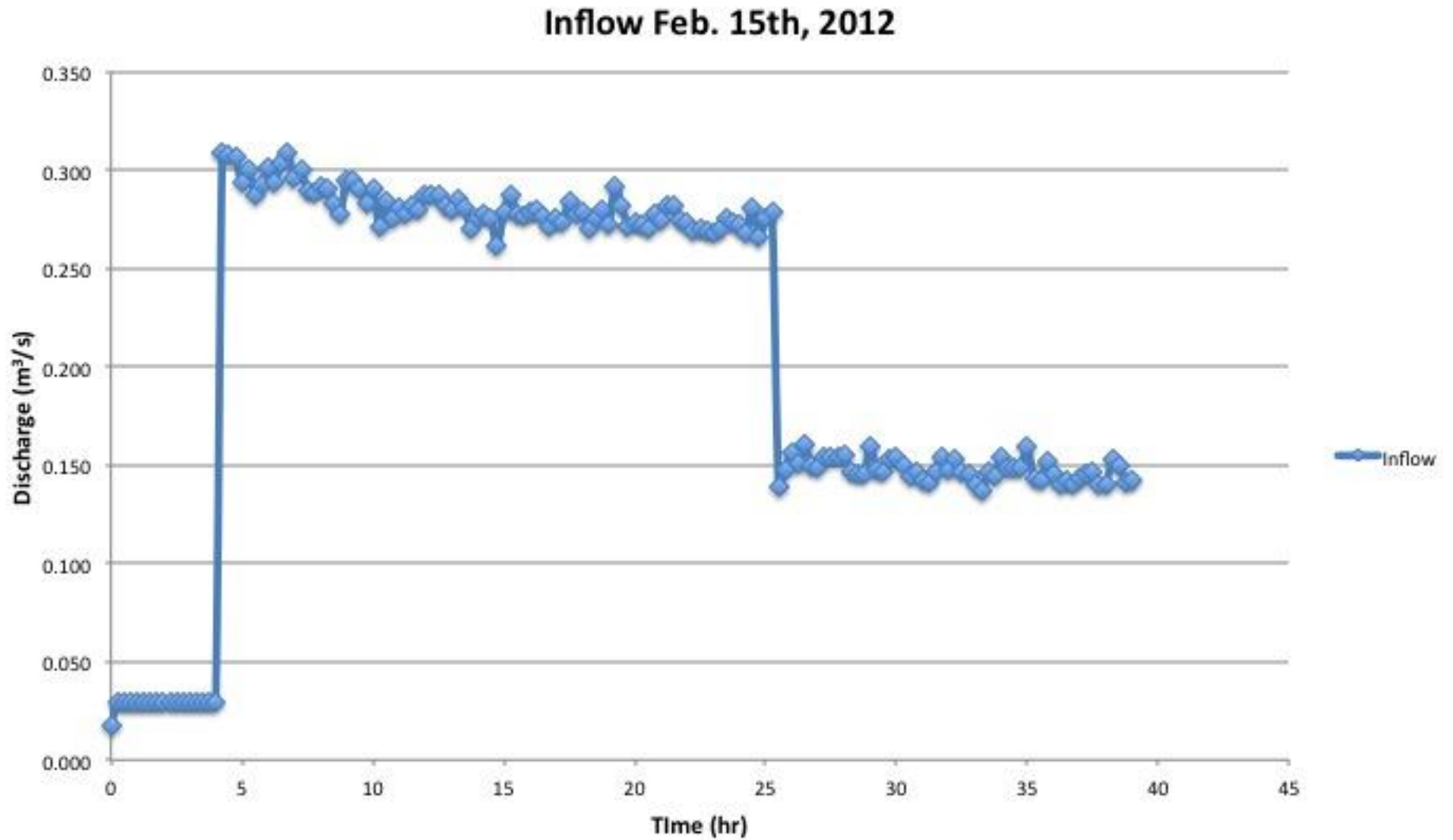
Elevation  
(m)



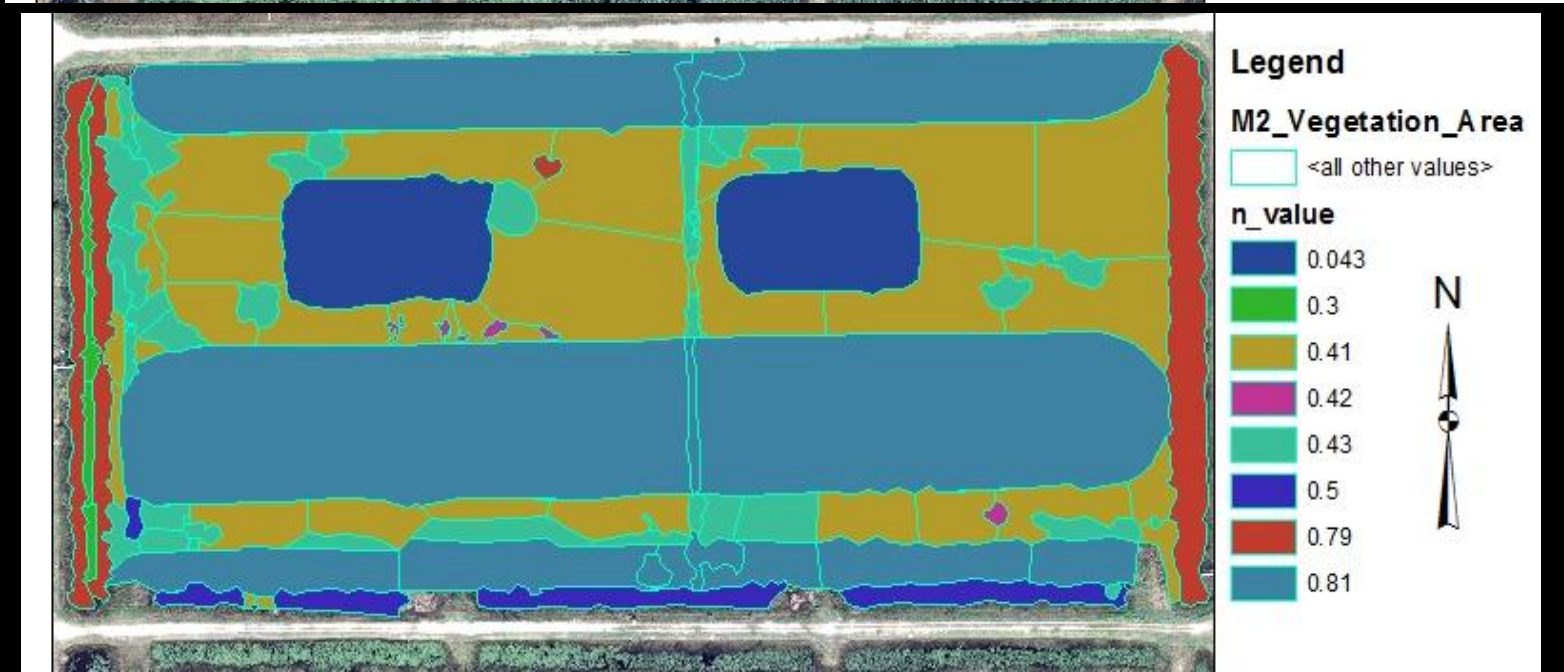
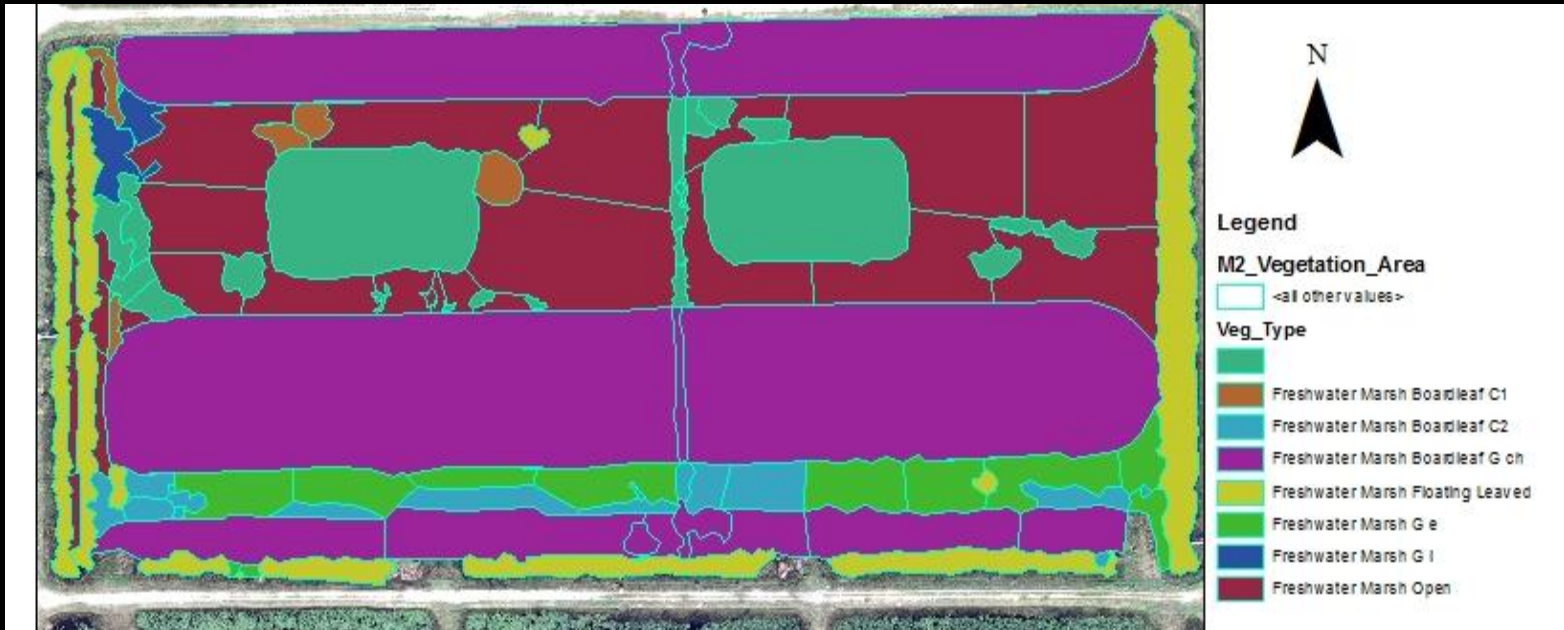
4.8 – 5.0  
4.5 – 4.8  
4.0 – 4.5  
4.8 – 5.0



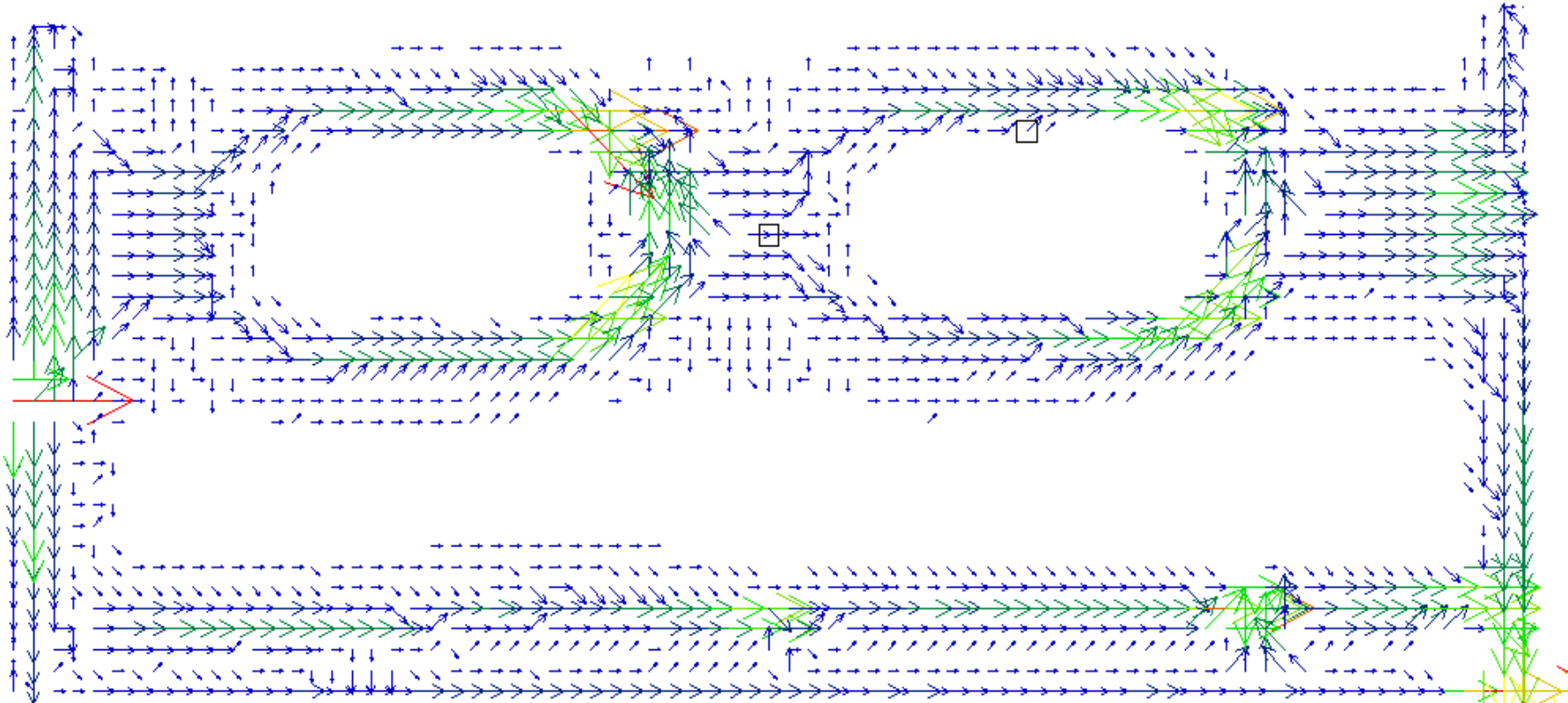
# Discharge Data



# Vegetation Coverage and Roughness



# FLO-2D: Maximum Velocity



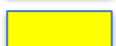
m/s



0.09 – 0.11



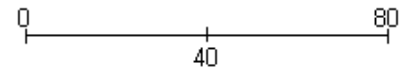
0.04 – 0.08



0.08 – 0.09

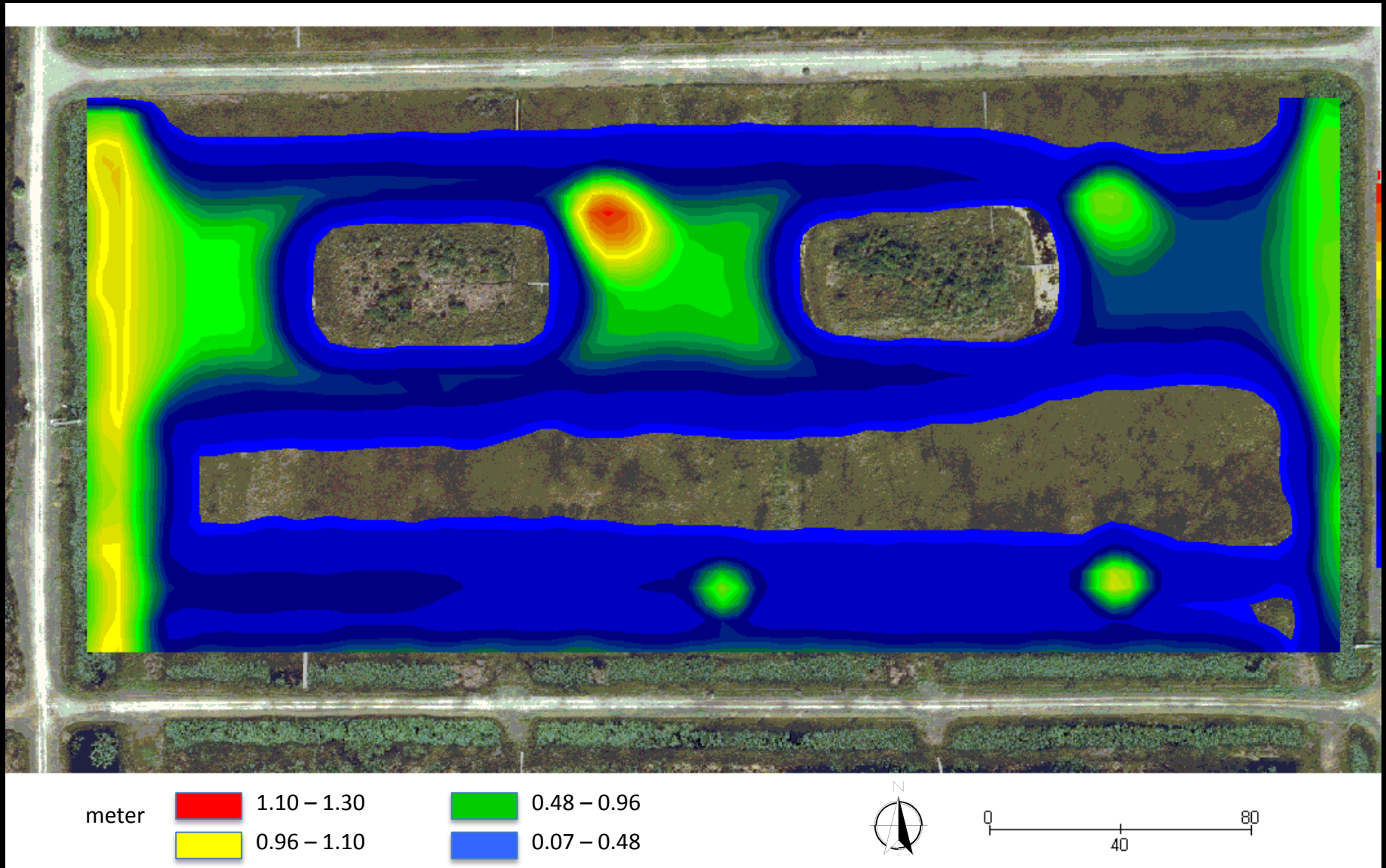


0.006 – 0.04





# FLO-2D: Maximum Flow Depth





# Data Collection



# Numerical Methodology

$$\frac{\partial(hC)}{\partial t} + \frac{\partial}{\partial x}(hCV_x) + \frac{\partial}{\partial y}(hCV_y) - \frac{\partial}{\partial x} \left( \frac{\partial}{\partial x} hD_x C \right) - \frac{\partial}{\partial y} \left( \frac{\partial}{\partial y} hD_y C \right) = W$$

Local  
Term

Advection

Dispersion

Source  
Sink

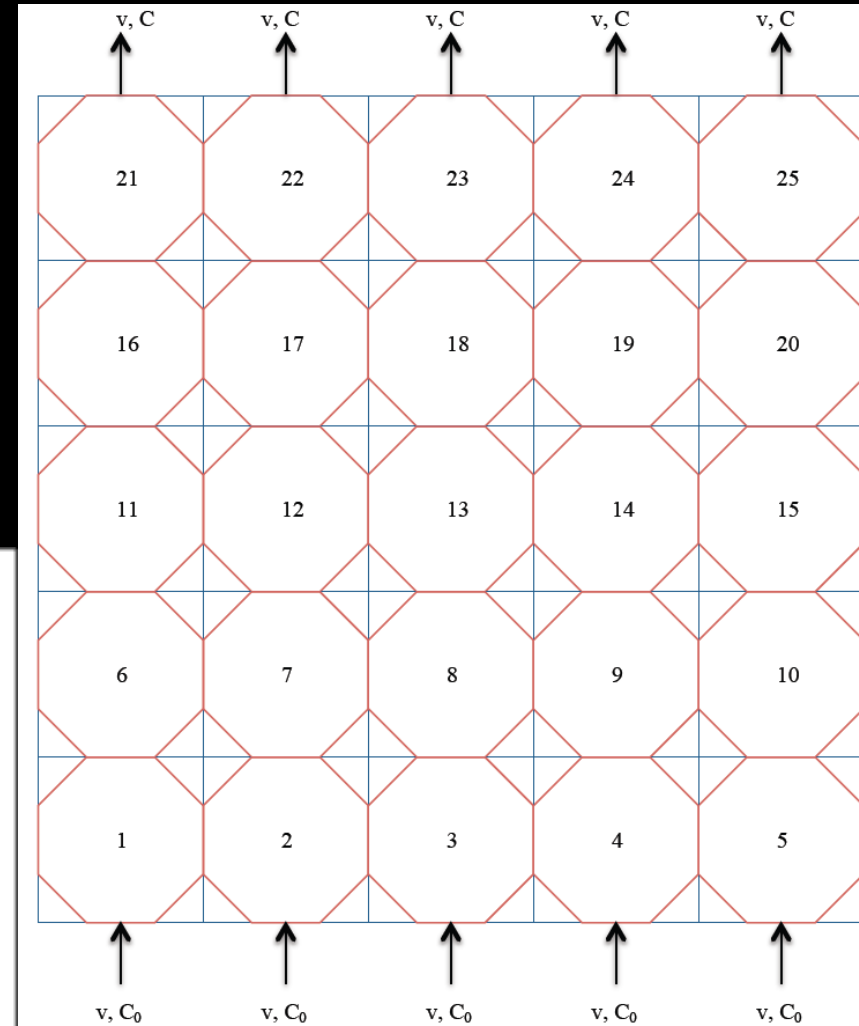
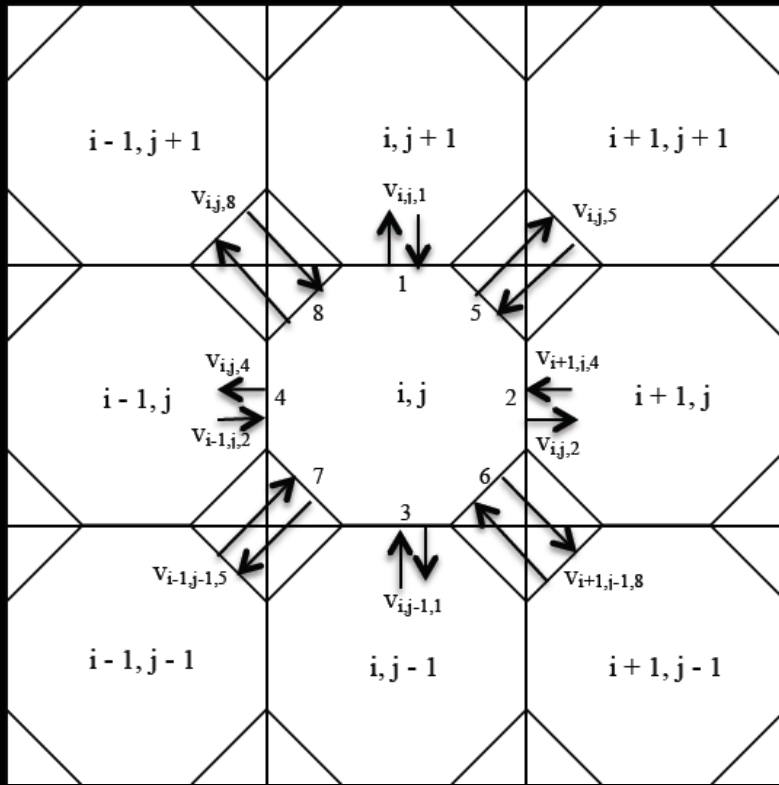
$$(1 - n) \frac{\partial z_b}{\partial t} + \frac{1}{r} \frac{\partial(hC)}{\partial t} + \frac{\partial q_x}{\partial x} + \frac{\partial q_y}{\partial y} = 0$$

Bed  
Elevation

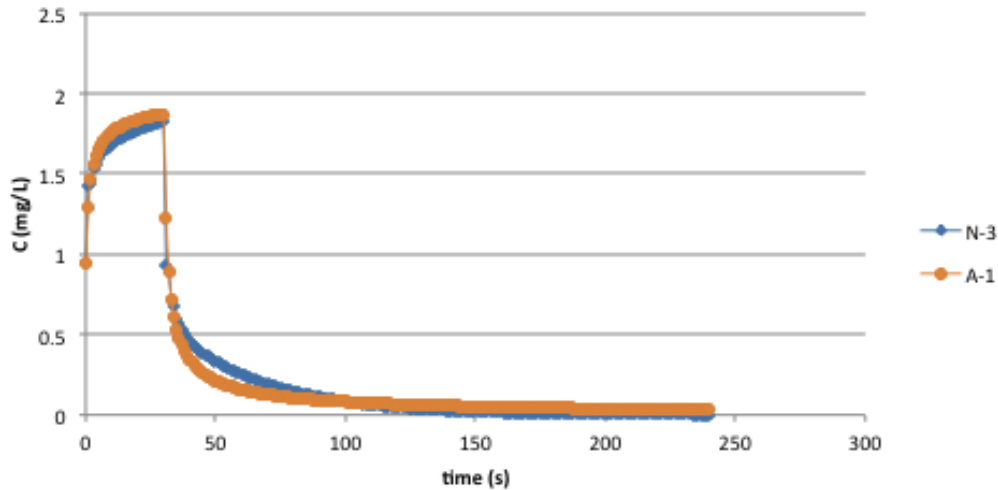
Local  
Concentration

Flux

# Numerical Results



**Numerical and Analytical results**



# FCE Research Contribution

**Biogeochemical  
Cycling**

**Climate & Disturbance Legacies**

**Organic Matter  
Dynamics**

**Carbon Cycling**

**Trophic Dynamics**

**Primary Production**

**Hydrology:  
Water Policy &  
Practices**

**Scenarios &  
Modeling**

# Acknowledgement

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Dr. Fernando Miralles

Earth and Environment Department ,  
Florida International University

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Dr. Reinaldo Garcia

Civil and Environmental Engineering  
Department, Florida International University

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Dr. Rene Price

Earth and Environment Department ,  
Florida International University

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Dr. Leonard Scinto

Earth and Environment Department ,  
Florida International University

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Dr. Rosanna Rivero

University of Georgia

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Eric Cline

SFWMD, LILA

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