FCE ASM 2014

MODELING & SCENARIOS
CROSS-CUTTING THEME

GENERAL QUESTION 1: How does the balance of fresh and marine water supply to the oligohaline ecotone influence microbially-mediated C and nutrient cycling in soils and water?

GENERAL QUESTION 2: How does the balance of fresh and marine water supply to the oligohaline ecotone influence the composition, distribution, and productivity of primary producers?

GENERAL QUESTION 3: How do surface water residence times, P availability, and salinity interact to affect OM quality, abiotic and biotic processing, and exchange between freshwater, ecotone, and marine environments?

GENERAL QUESTION 4: How will SLR interact with changes in freshwater inflows to modify detrital food webs and the spatial scale of consumer-mediated habitat linkages?

GENERAL QUESTION 5: How do climate change and SLR interact with water management practices to control hydrologic conditions in the oligohaline ecotone?

GENERAL QUESTION 6: How do changing freshwater inflows, tidal and storm cycles, and climate patterns affect the magnitude, rates, and pathways of C sequestration, loss, storage, and transport across the land-water continuum?

GENERAL QUESTION 7: How have the legacies of wetland conversion to urban and agricultural land uses and resulting shifts in water demand/management across the Everglades watershed changed the sensitivity of the coastal zone to freshwater restoration in the face of SLR?

GENERAL QUESTION 8: What scenario of water distribution and climate change will maximize socio-economic and environmental sustainability of a future FCE?
RESULTS: P-Sorption

Hypothesis:
Dynamic Water Chemistry $\rightarrow$ P sorption reversals

Sediment-water interface

Mangrove Root Zone
RESULTS: P-Sorption

In the Mangrove Ecotone, Many P-Sorption Drivers Changing Simultaneously.
RESULTS: P-Sorption

In the Mangrove Ecotone, Many P-Sorption Drivers Changing Simultaneously
RESULTS: P-Sorption

Proposed by Millero et al., 2001
RESULTS: P-Sorption

Question 1: What role is played by $\text{HCO}_3^-$?

![Diagram showing P sorption by Taylor Slough Ecotone Sediment (TS/Ph 6b).]

$P_{\text{adsorbed, \mu mol/g}}$

- Bicarbonate Freshwater
- 50-50 Mix
- Artificial Seawater

$R^2 = 0.87$

(initial P concentration of 8 uM)
RESULTS: Residence Time

**Turnover time** ($V/Q_{out}$): Time all water remains in the control volume (e.g., Taylor Slough).

Water flushing times varied seasonally
- May – Shortest
- December – Longest

Water flushing times were inversely correlated with ET.

Sandoval, 2013
RESULTS: Residence Time

PROBLEM: THIS IS HARD
  • Data Hungry
    • Surface Characteristics
      • Topography (DTM)
      • Roughness (DSM)
    • Hydraulic Gradients (density dependent!)
  • Computationally Challenging
    • Advection and Dispersion
    • Reactions
RESULTS: Residence Time
RESULTS: Residence Time

a) DTM (Digital Terrain Model)
   Last Returns

b) DSM (Digital Surface Model)
   First Returns

Bare Earth
Lacking Bathymetry!
Vegetation Height
RESULTS: Residence Time

- Tides create steep hydraulic gradients along channel margins and heads
- Effects geographically extensive
  - 2-3 km laterally from channel margins
  - 3-4 km longitudinally upgradient from channel heads
RESULTS: Residence Time

Mean advection

\[ 0.93 \pm 0.45 \text{ km d}^{-1} \]

Longitudinal dispersion

\[ 17.9 \pm 5.5 \text{ m}^2 \text{ s}^{-1} \]
RESULTS: Residence Time

• Ongoing
  – Better develop conceptual model (it’s complicated – e.g., Wdowinski et al. [2013] and Cawley et al. [2013])
  – Construct and test synthetic models – Is a 1D model with a lateral exchange function (e.g., Ribbon models) sufficient?

• Next Steps
  – Parameterize model using real data
  – Simulate
    • Conservative particle (e.g., Cl⁻) fate and transport
    • Reactive particle (e.g., DOC) fate and transport?
Can pulsed flows increase erosion, transport and deposition and therefore cause net elevation change?

LILA, Mesocosm 2

Loosely linked models
- Flow depths and velocities
- Erosion, transport, and deposition
- Bed elevation change

Two Scenarios
- Normal Scenario – 1-2 cm/s
- Pulsed Scenario – 3-5 cm/s
RESULTS: Sediment Transport
RESULTS: Sediment Transport

Net change pretty close to zero because floc moves but peat doesn’t....
RESULTS: Scenarios

- Manageable number of plausible outcomes – Not projections!!
- BUT TO WHAT END?
  - To develop products to better understand relationships between forcings and response variables (e.g., models)
  - To develop products to better understand human perceptions of risk and consequence (e.g., surveys)
- Common storylines enhance likelihood of opportunistic integration and synthesis
**Climate Change**: Latest IPCC GCMs downscaled to generate daily rainfall and ET for south Florida; formatted for input into SFWMM Penn State Univ.

**Water Use**: Future water demands based on development patterns; calculated separately for agriculture, residential, commercial, industrial and government sectors. Univ. of Miami, FSU

**LULC Change**: Rule-based projections at parcel level; representation of socioeconomic dimensions; future work to represent changes in hydrologic conditions and natural communities. GeoDesign Inc., PFLCC

<table>
<thead>
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<th>Scenario 1</th>
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| **Conservation (strategy + mechanism)** | **50% Fee Simple**  
**50% Easement**  
**Florida Forever targets** |
| **Urbanization** | **BAU**  
**Low density greenfield development**  
**Existing distribution of density** |
| **Sea Level Rise** | **1 meter by 2100** |

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| **Conservation (strategy + mechanism)** | **10% Fee Simple**  
**90% Easement**  
**Florida Forever targets** |
| **Urbanization** | **PRO**  
**Green infrastructure+ Redevelopment + Densification** |
| **Sea Level Rise** | **1 meter by 2100** |
RESULTS: Scenarios
RESULTS: Scenarios

Sea Level Rise in Tampa Bay
Elzbieta Bialkowska-Jelinska, Meg Stack and Corinne Zeller

Storm Surge: Created by Wind, Waves & Pressure

- Storm surges are rises of water that can increase by feet in minutes, based on the size, speed and intensity of a hurricane, the angle of approach to the shore and coastal water depth.
- Storm surges can move about 10-15 mph, one cubic yard of cut water weighs almost a ton.
- A surge can begin before storm landfall, making escape difficult and driving dangerous.
- The Gulf of Mexico is vulnerable to storm surges, which will potentially worsen with climate change and sea level rise. As water temperatures increase, stronger storms will form.
- How can YOU help protect Tampa Bay and reduce effects of climate change?

Historic Landmarks Threatened Due to Climate Change by 2100

Modified with Permission from the Tampa Bay ULTRA-Ex
RESULTS: Scenarios

The top priority was a giant pink hotel (i.e., The Don Cesar)

Modified with Permission from the Tampa Bay ULTRA-Ex
MAJOR MILESTONES

• Personnel
  – 43 members – 34% growth in the past year!!
  – Important new members (e.g., Tartakovsky, Wdowinski, Ho)

• Funding
  – Completely reorganized and reprioritized funding

• Papers
  – Modeling played a central role in ~25% of papers in 2013
SYNTHESIS

Diatom-based Models for Inferring Hydrology and Periphyton Abundance in a Subtropical Karstic Wetland: Implications for Ecosystem-Scale Bioassessment

Sylvia S. Lee • Evelyn E. Gaiser • Joel C. Trexler

Evaluating Effects of Everglades Restoration on American Crocodile Populations in South Florida Using a Spatially-Explicit, Stage-Based Population Model

Timothy W. Green • Daniel H. Stone • Eric D. Swain • Michael S. Cherkes • Melinda Lohmann • Frank J. Mazotti • Kenneth G. Rice
3rd YEAR REVIEW

• Improve leadership (e.g., better facilitate integrated modeling)
  – Responsibilities – Rains, Fitz
  – Timeline – ASAP

• Select scenarios
  – Responsibility – Many of us
  – Timeline – Fall 2014

• “Field test” scenarios with some scenarios modeling
  – Responsibility – Fitz (ELM)
  – Timeline – By ASM 2015

• Finish, finish, finish….
DISCUSSION POINTS

• Integrated modeling (data-model; model-model)
  – Make connections today
  – Better enable the making of connections tomorrow

• Scenarios Workshop
  – Goals
  – Timing
  – Format
  – Participants