**COMPREHENSIVE MARSH MODEL DEMONSTRATION:** SEVEN MILE ISLAND INNOVATION LABORATORY, NEW JERSEY

Thomas Huff, Ph.D. Emily Russ, Ph.D. Todd Swannack, Ph.D.

EMRRP Webinar Series February 12, 2024







US Army Corps U.S. ARMY of Engineers

# **USACE NEEDS INTEGRATED MARSH MODELS**



- Current modeling systems do not provide the level of precision and detail that USACE needs for restoration planning and engineering operations
- Integrated modeling systems capture feedbacks between physical and ecological processes
- We developed an integrated modeling framework for coupling marsh models of different scales (Comprehensive "Comp" marsh model)

UNCI ASSIFIFD



## PLANNING MODELS FOR MARSH RESILIENCE



- Marshes important for flood risk management, environmental, and social benefits
- Marshes vulnerable to natural (e.g., SLR) and anthropogenic threats • (e.g., development)
- Planning future changes and marsh dynamics is challenging because of interacting components
- Need integrated modeling framework to capture complex systems

# **MARSH = HYDRO+MORPHO+ECO DYNAMICS**















## **SEVEN-MILE ISLAND INNOVATION LABORATORY**









Collaborative initiative to develop innovative BUDM applications for marsh restoration in NJ

















- Model developed using the python based Landlab Toolkit developed by Community Surface Dynamics Modeling System (CSDMS)
- Modular, standardized components for earth surface dynamics that are easily integrated
- Coupled tidal flow, morphology (Mariotti et al., 2018), and vegetation (Morris et al., 2002) components





# **COMP MODEL: MODEL INTEGRATION**







### **COMP MODEL: CONCEPTUAL DIAGRAM**







### **COMP MODEL: DEMO SITE**











# **COMP MODEL: INPUTS/SCENARIOS**



- The model allows for a multitude of input parameters
- Main variable of interest
  - Sea level rise



### User defined inputs

- Mean sea level
- Tidal range
- Sediment density
- Tidal sediment dispersion
- Critical shear stress
- Settling velocity
- Soil porosity
- Suspended sediment concentration
- Bedload downslope coefficient
- Initial ponding depth
- Pond expansion rate
- Roughness
- ETC



# **COMP MODEL: VEGETATION DYNAMICS**

- Modified SLR scenarios drive the changes in the model.
- The addition of the CWEM adds model complexity.







### **COMP MODEL: RSLR VS LAND COVER**





# **COMP MODEL: VEGETATION OUTPUTS**

- The parametric vegetation index allows for a more complex calculation of Manning's Coefficient
- This influences erosion and subsequent vegetation development
- CWEM integration allows for a spatially explicit accretion calculation







## **COMP MODEL: FUTURE MODULES/COMPONENTS**



- Additional modules to plug in.
  - Ponding (in development)
  - Wave erosion (not yet started)







With Ponding







#### Without Ponding



## **COMP MODEL: GULL ISLAND DEMO**

With Ponding



uplands

mudFlats

marsh sparse

marsh moderate

marsh dense

water

50

400

Without Ponding



## **FUTURE WORK**

- Assess model performance
  - Compare to real world conditions
  - Test against other models
  - Add additional "modules" such as wave erosion.

- Model Certification
  - Work with EMRRP (Brook) and EcoPCX







- Mariotti G, Murshid S. (2018). A 2D Tide-Averaged Model for the Long-Term Evolution of an Idealized Tidal Basin-Inlet-Delta System. Journal of Marine Science and Engineering. 6(4):154. <u>https://doi.org/10.3390/jmse6040154</u>
- Morris, J.T., Sundareshwar, P.V., Nietch, C.T., Kjerfve, B., Cahoon, D.R., (2002) Responses of Coastal Wetlands to Rising Sea Level, Ecology, 83(10) p 2869-2877. https://doi.org/10.1890/0012-9658(2002)083[2869:ROCWTR]2.0.CO;2
- Russ, E.R., T.S. Cagle., and T.M. Swannack. 2024. Considerations for Integrating Ecological and Hydrogeomorphic Models: Developing a comprehensive Marsh Vegetation Model. (ERDC/TN EMRRP-EM-12). Vicksburg, MS: US Army Engineer Research and Development Center. <u>http://dx.doi.org/10.21079/11681/48131</u>

# **CONNECT WITH US**

### **EcoMod**

**Environmental Laboratory U.S. Army Engineer Research and Development Center U.S. Army Corps of Engineers** ecomodteam@usace.army.mil https://ecomod.erdc.dren.mil

### ecomod

#### Thomas.P.Huff@usace.army.mil

### Emily.R.Russ@usace.army.mil

**US Army Corps** 

of Engineers

U.S. ARMY

Todd.M.Swannack@usace.army.mil

ERDC

