Coastal Resilience: The Environment, Infrastructure, and Human Systems

ERDC
Engineer Research and Development Center

USACE Flood Risk Management and Sustainable Coastal Infrastructure

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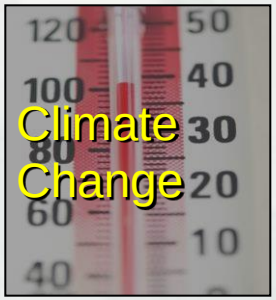
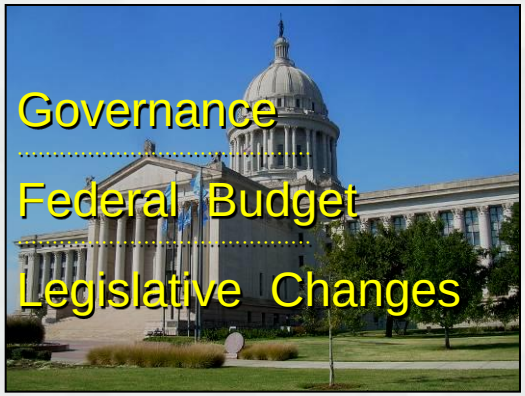
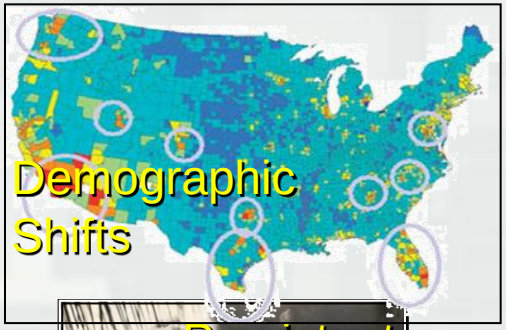
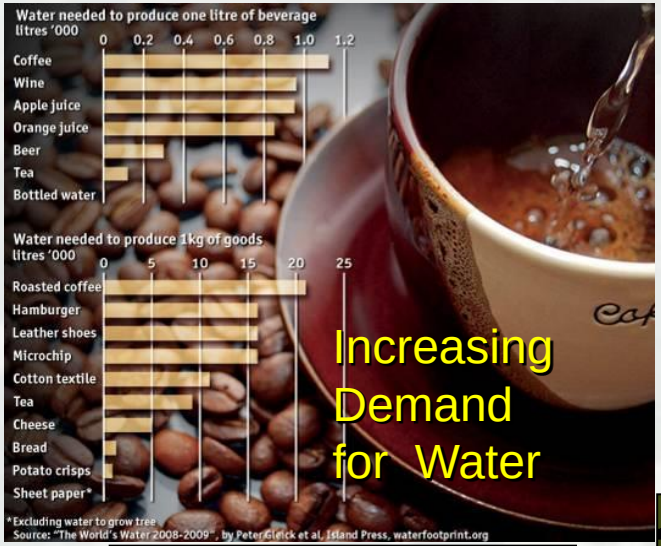
US Army Corps of Engineers®

National Water Resource Challenges









Value to the Nation
USACE Flood Risk Management

Operates 600+ dams, 383 major lakes and reservoirs

- 376M visitors/yr, $15B in economic activity, 500,000 jobs
- 24% US hydropower capacity, 3% of US electricity, $500M in sales

25,000+ km of levees (some coastal)

100 coastal storm damage reduction and related projects including 650 km of shore protection

- Destination for 75% of US vacations

~12 Emergency responses per year

- Electricity, debris removal, water/ice distribution, temporary roofing, flood fight,…

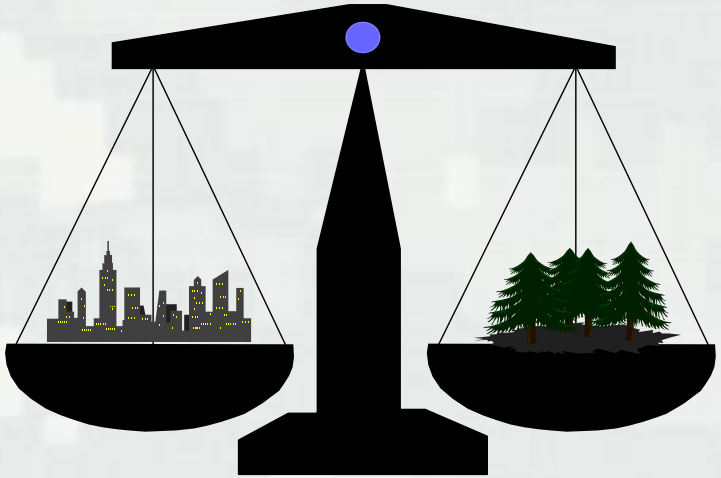
National Challenge:

Aging Water Infrastructure

- Many infrastructure projects 50+ years old
- Investments in water resources infrastructure declining in real terms
- Result: more frequent closures for repairs, decreased performance & costly delays

National Challenge:

Environmental Sustainability

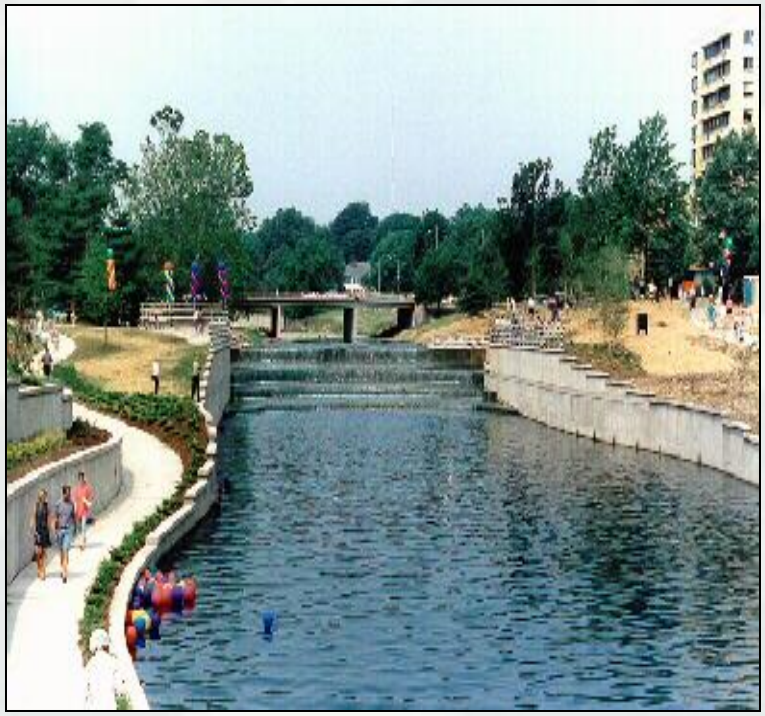


- Balance between economic development, environmental stewardship
- Water quality threatened on 8% of nation's rivers and streams
- Corps has authority and programs for ecosystem restoration.

National Challenge:

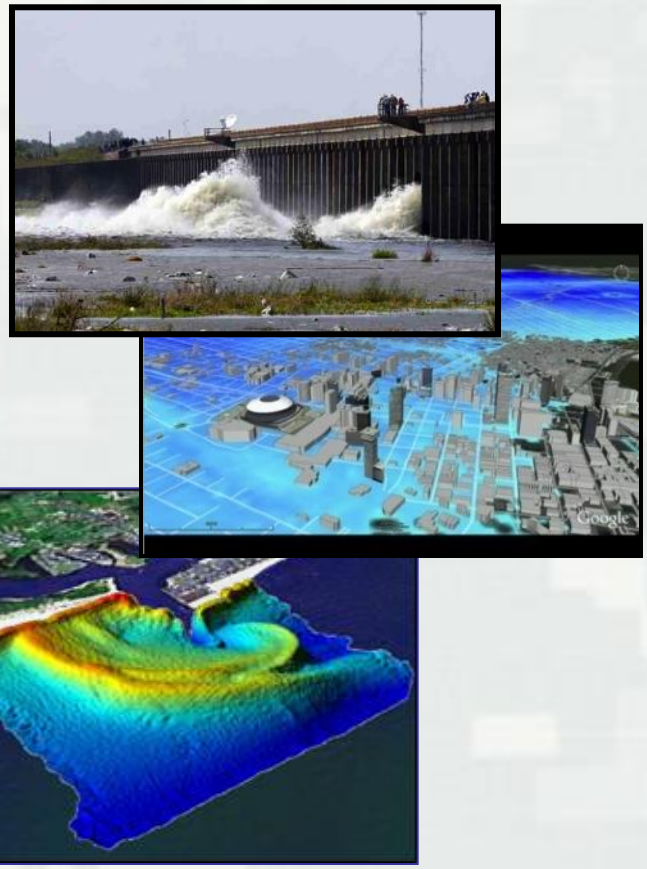
Integrated Water Resources Management

- Planning based on watershed / regional approach
- Ecosystem restoration
- Environmental sustainability
- Interagency coordination
- Involve all stakeholders

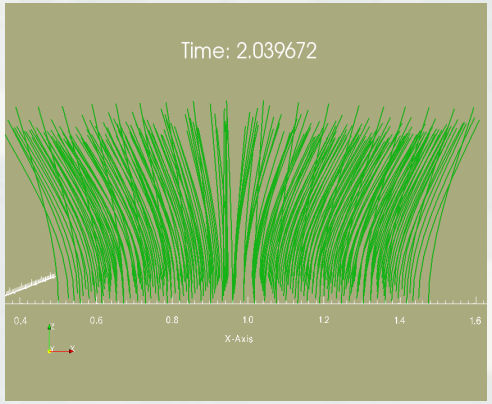


USACE Flood & Coastal Systems: Strategic R&D Themes

- Determine Risk & Uncertainty for Project Alternatives Evaluation & Performance
- Optimize Management of Coastal & Estuarine Resources
- Assess Comprehensive & Multidisciplinary Management of Watersheds
- Improve Flood Risk Management & Water Control Infrastructure Resiliency & Reliability
- Enable effective disaster preparation, response & recovery
- Engineering with nature to enhance ecosystem and processes, benefits and services

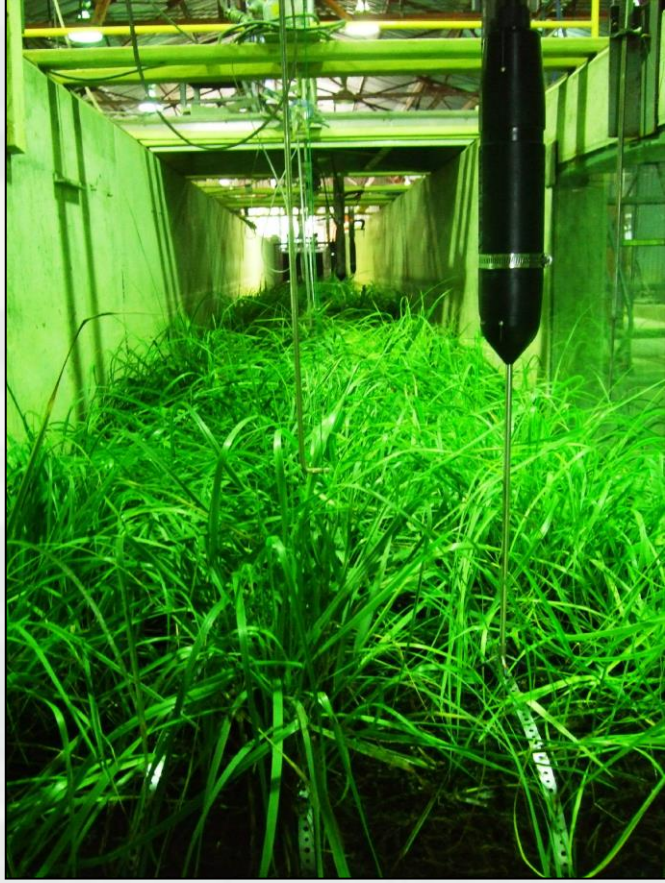


Research and Development: Wave Dissipation by Vegetation



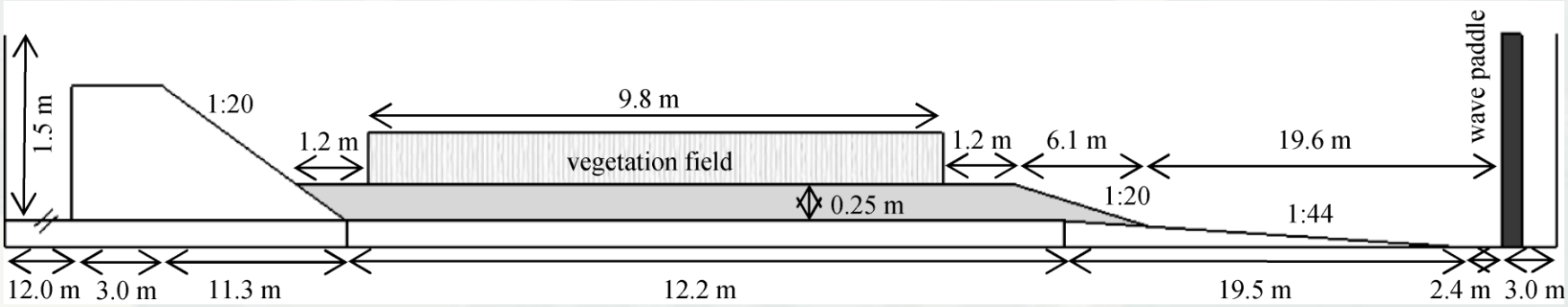
- Guidance to describe wave dissipation by natural features
- Complement traditional coastal protection
- Maximize ecological benefits and services

Approach

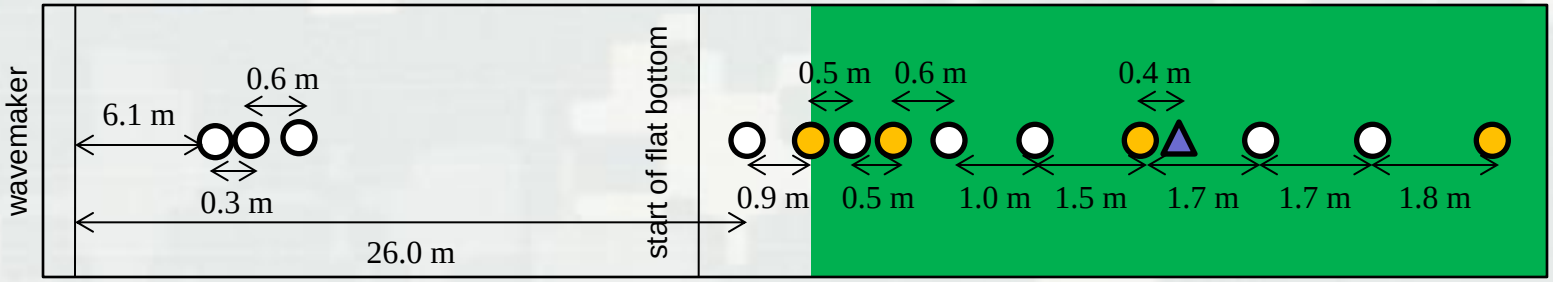


- Literature Review
- Laboratory Investigations
  - Tests with real vegetation
  - Documentation of tests and results
- Numerical Wave Flume (NWF)
- Phase-Averaged Numerical Model
  - Development of improved dissipation function for phase-averaged models
  - Evaluation of dissipation function in existing phase-averaged wave model and documentation (2014)

Flume/Instrumentation

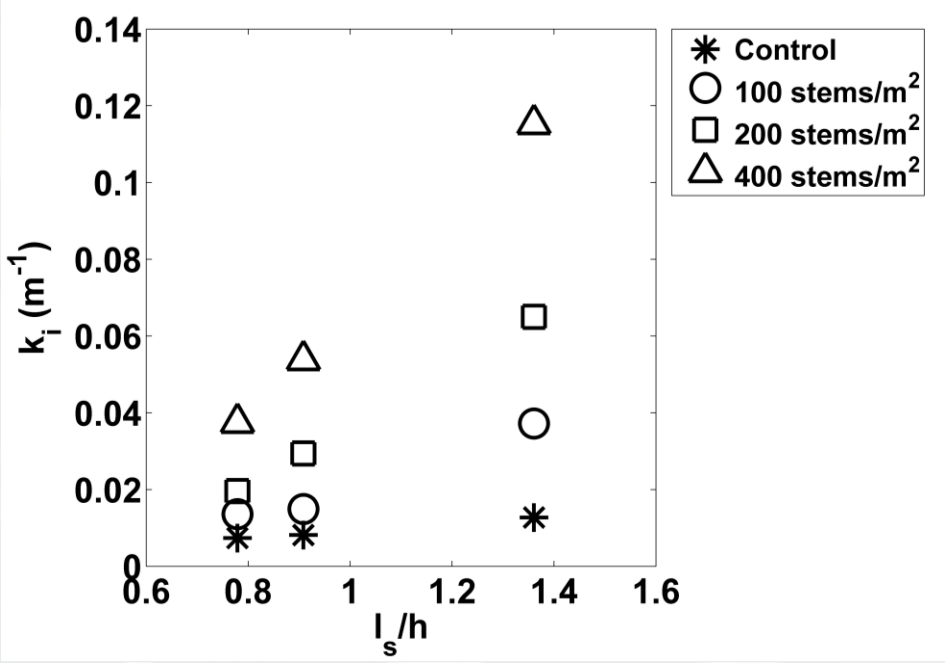


- 13 single-wire capacitance wave gauges
  - sampling rate: 25 Hz
- 4 ADVs paired with wave gauges
  - sampling rate: 25 Hz
- 1 high-resolution ADCP
  - sampling rate: 4 Hz
- waves generated for 8 minutes



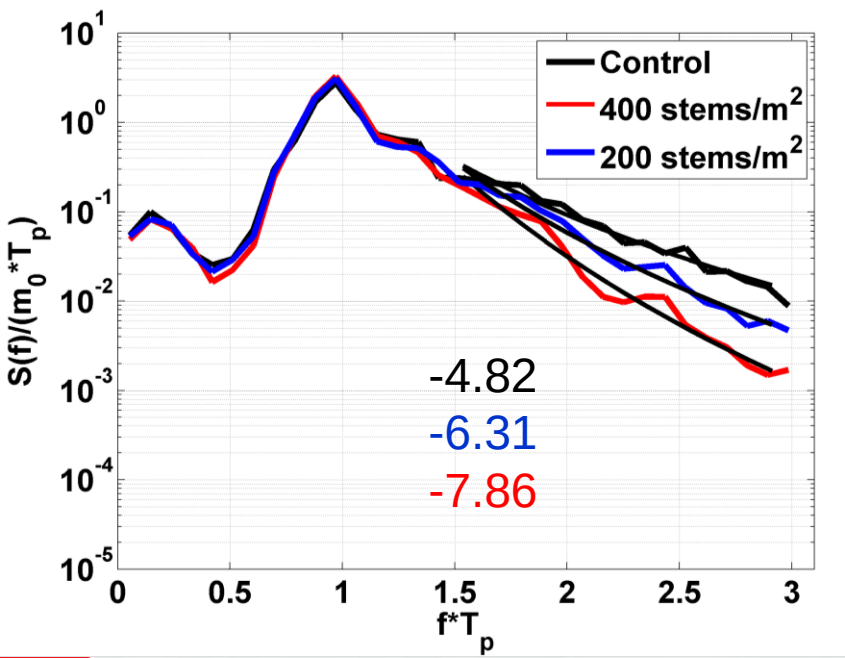
Trends in Wave Attenuation

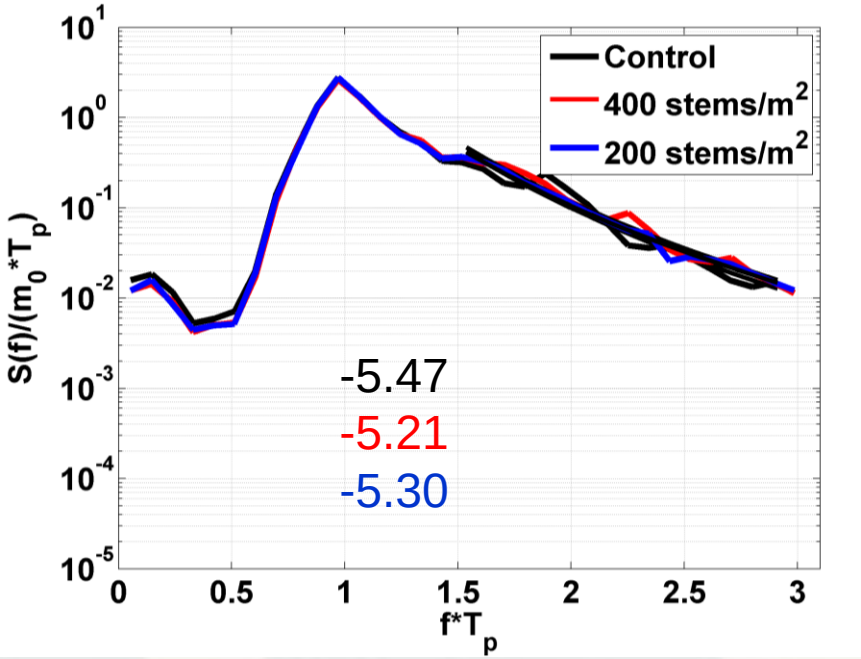
- Wave attenuation was found to:
  - increase with stem density
  - increase with submergence ratio
  - slight increase with incident wave height
  - marginal decrease with longer waves during emergent conditions with no discernible trend at $l_s/h = 0.78$
- described wave decay very well (lowest $R^2 = 0.82$)



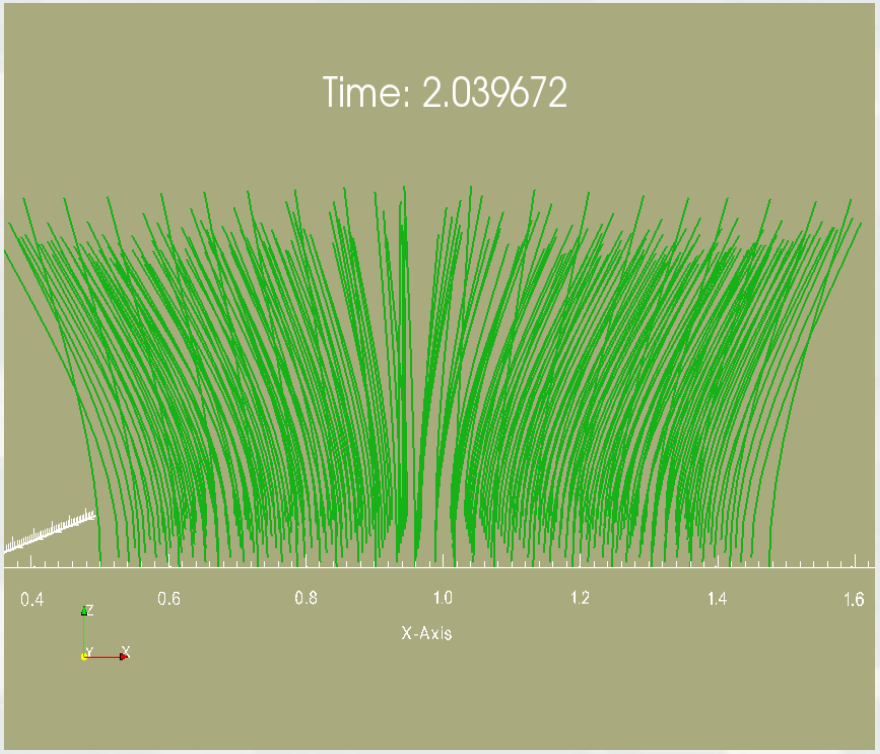
Equilibrium Range

- dissipation of higher frequencies also dependent on stem density and submergence ratio
- suggests current parameterizations not valid for spectra propagating through emergent canopies



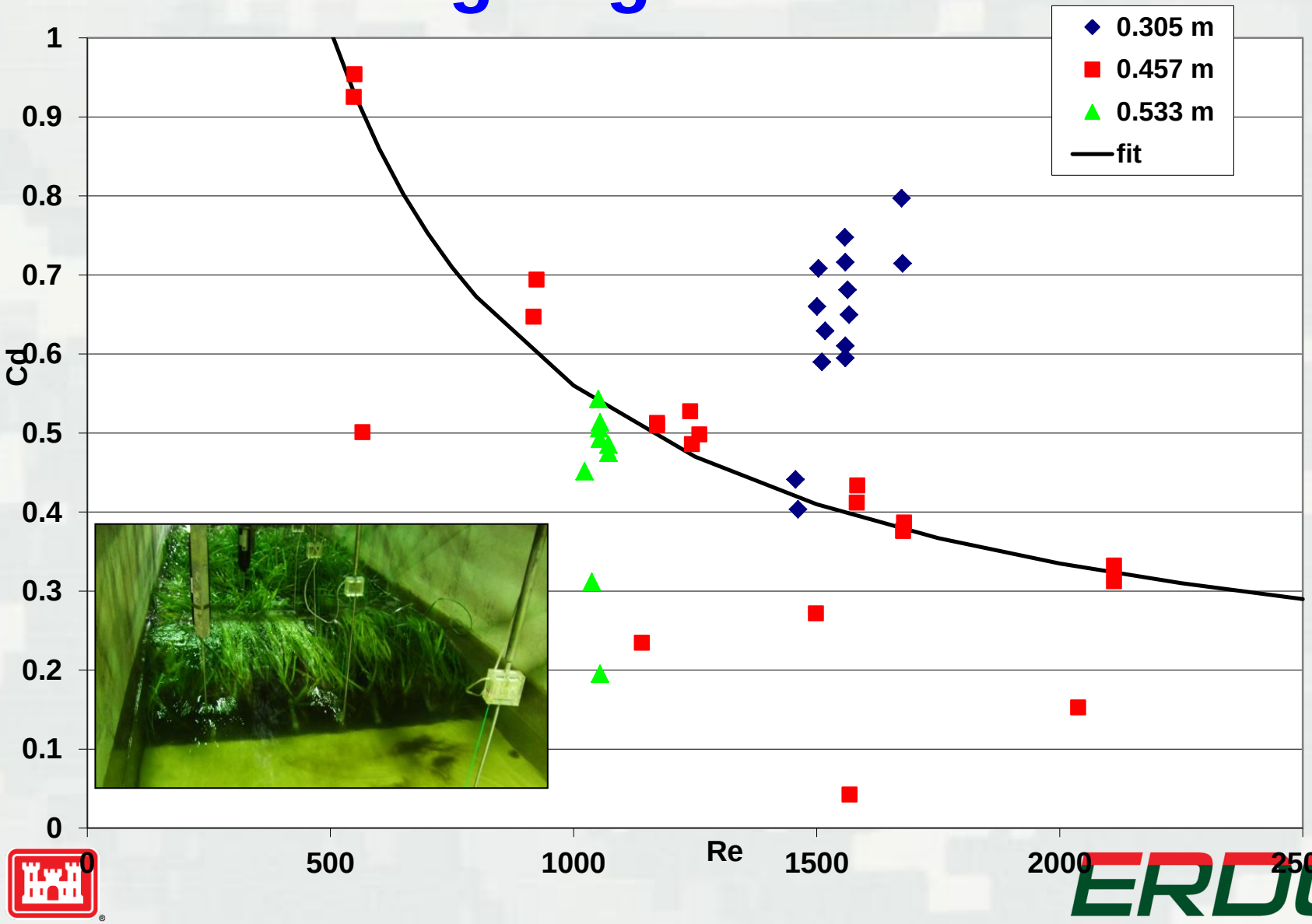


Immersed Boundary Approach

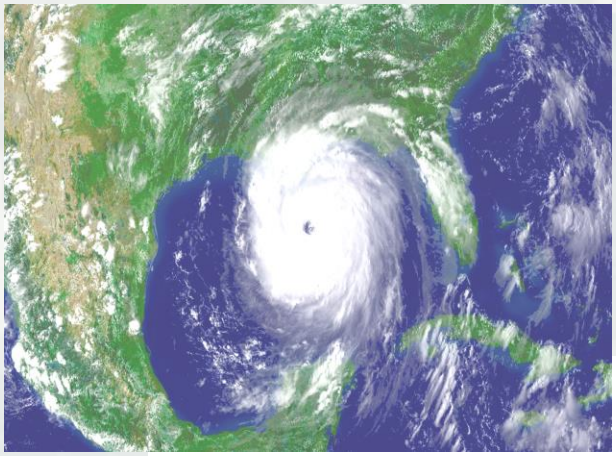


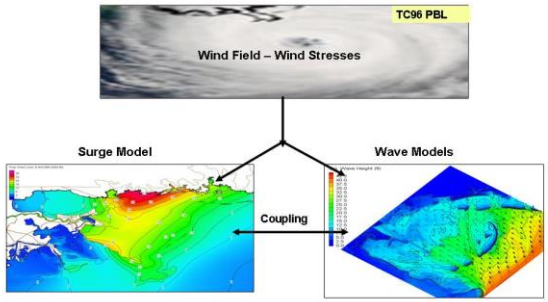
- A numerical approach for representing thin structures
- Behaves well when structures touch and when their deformation can be described with simple models (e.g. beam theory)
- Gives up the ability to represent the geometry of the structure precisely

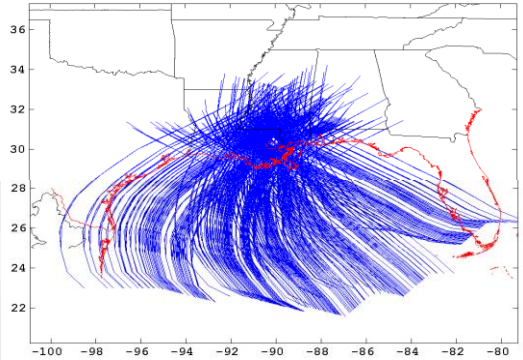
Ongoing Research

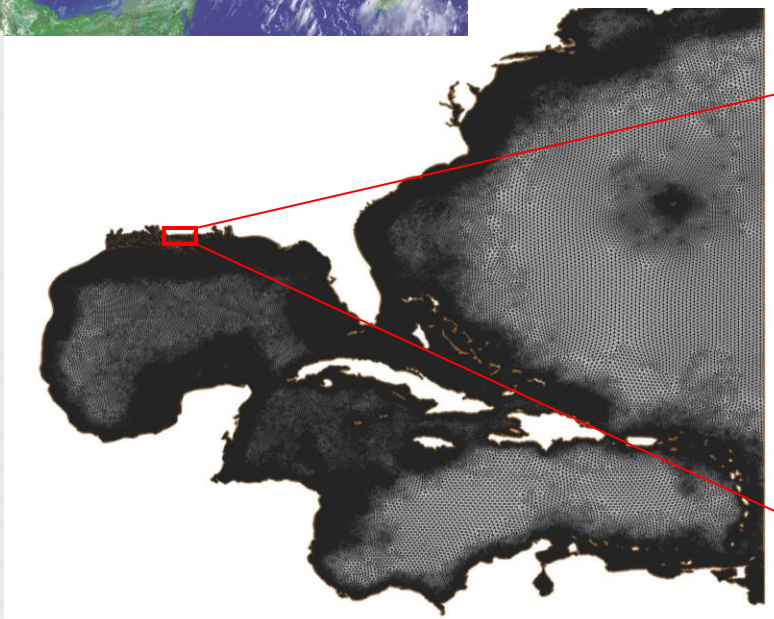


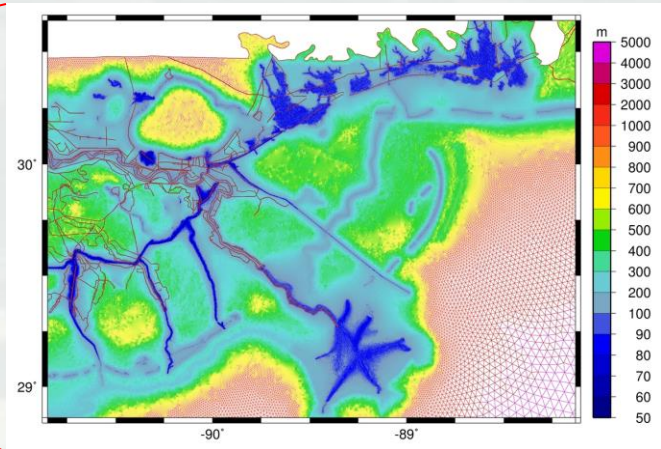
Coastal Storm Modeling System (CSTORM-MS)











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Thank You

Reference: Anderson, M.E. And J.M. Smith. 2014. Wave attenuation by flexible, idealized salt marsh vegetation. Coastal Engineering 83, 82-92