Where and What is Water at UCF?

OverFLoW Seminar Series

January 21, 2025

FLoWCenter

CONTENTS

Introduction: Where and What is Water at UCF?

<u>Water-related degrees offered at UCF:</u>

BS Biology Marine & Aquatic Track, MS/PhD Conservation Biology

Water Resources Engineering Tracks in Civil Engineering, BS/MS/PhD

*No. 76-100 in Shanghai Ranking 2024

Environmental Engineering BS/MS/PhD

Emergency Management and Homeland Security BS/MS/GC

*Ranked the No. 1 graduate program in Emergency Management and Homeland Security by U.S. News and World Report in 2024

Hospitality and Tourism Management BS/MS/PhD/GC

*No. 4 in Shanghai Ranking 2024

Public Administration

*No. 20 in Shanghai Ranking 2024

Anthropology BA/MA

Chemistry BS/MS/PhD

<u>Water-related student clubs at UCF:</u> Student chapters IAHR, American Society of Civil Engineers, Society of Environmental Engineers, Engineers Without Borders

UF Howard T. Odum Center for Wetlands
UNIVERSITY of FLORIDA

Applying ecohydraulics research to the robust design of natural infrastructure: Sediment transport and retention in complex biological canopies

Kelly Kibler, Ph.D., Associate Professor, Department of Civil, Environmental and Construction Engineering, University of Central Florida

Oct. 23rd, 2024

101 Phelps Lab, 11:45 am

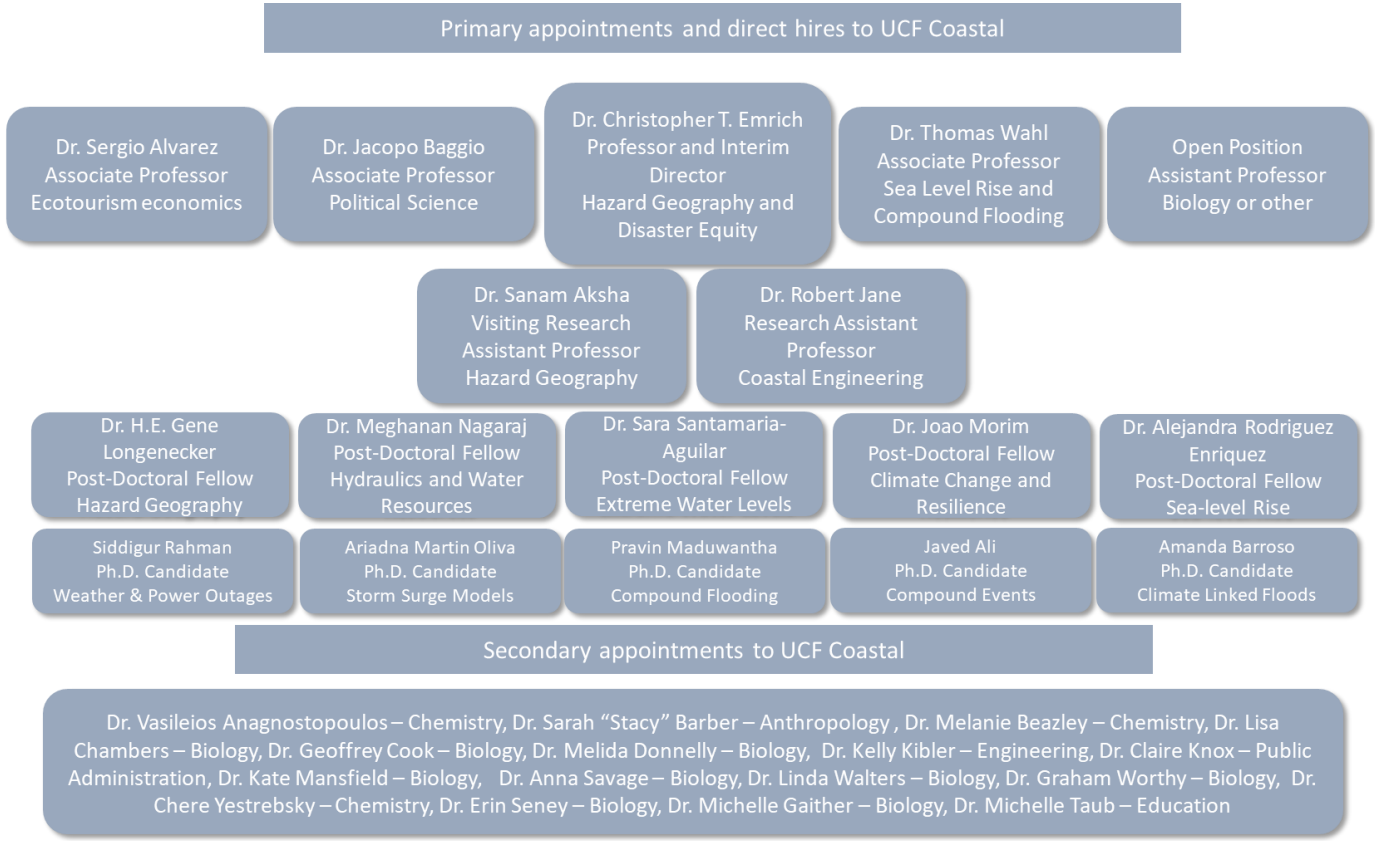
Join us for the livestream or view later:
https://youtube.com/live/vDnzPCPdsto?feature=share

National Center for Integrated Coastal Research

UCF Coastal

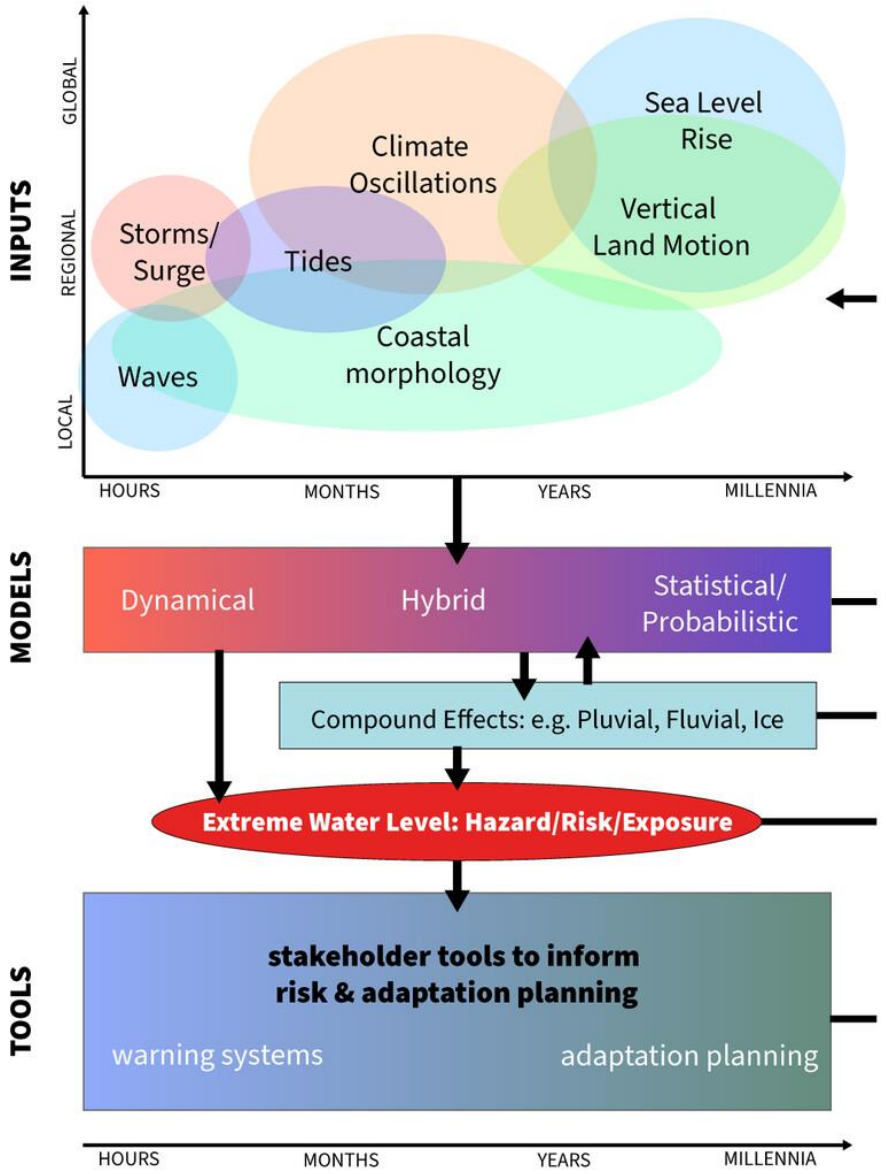
National Center for Integrated Coastal Research Mission

Be the nation's **preeminent sustainable coastal systems program**, bringing together a transdisciplinary team to integrate science and social needs into more **effective economic development and planning**, **environmental stewardship**, **hazard mitigation planning**, and **public policy development** by linking the ecological security of coastal ecosystems with the economic security of coastal communities.



Coastal Risks and Engineering Lab

- Sea level rise
- Tides, storm surges, waves
- Coastal flooding and erosions
- Compound climate hazards



CORE LAB
COASTAL RISKS & ENGINEERING

Rodriguez et al., 2024

UCF

Coastal Tourism, Recreation & Sustainability

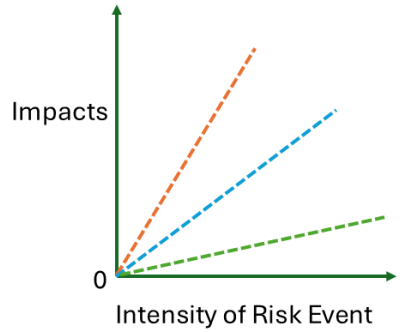
Interaction of human and physical dimensions of risk:

- Harmful Algae Blooms and Tropical Cyclones

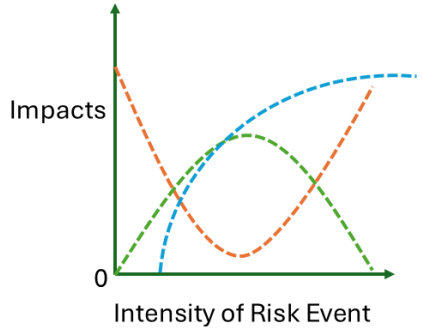
Economic valuation of environmental or sustainability-related attributes:

- Changes in water quality
- Characteristics of island destinations

Opportunities to transform coastal tourism from exploitative to regenerative frameworks.



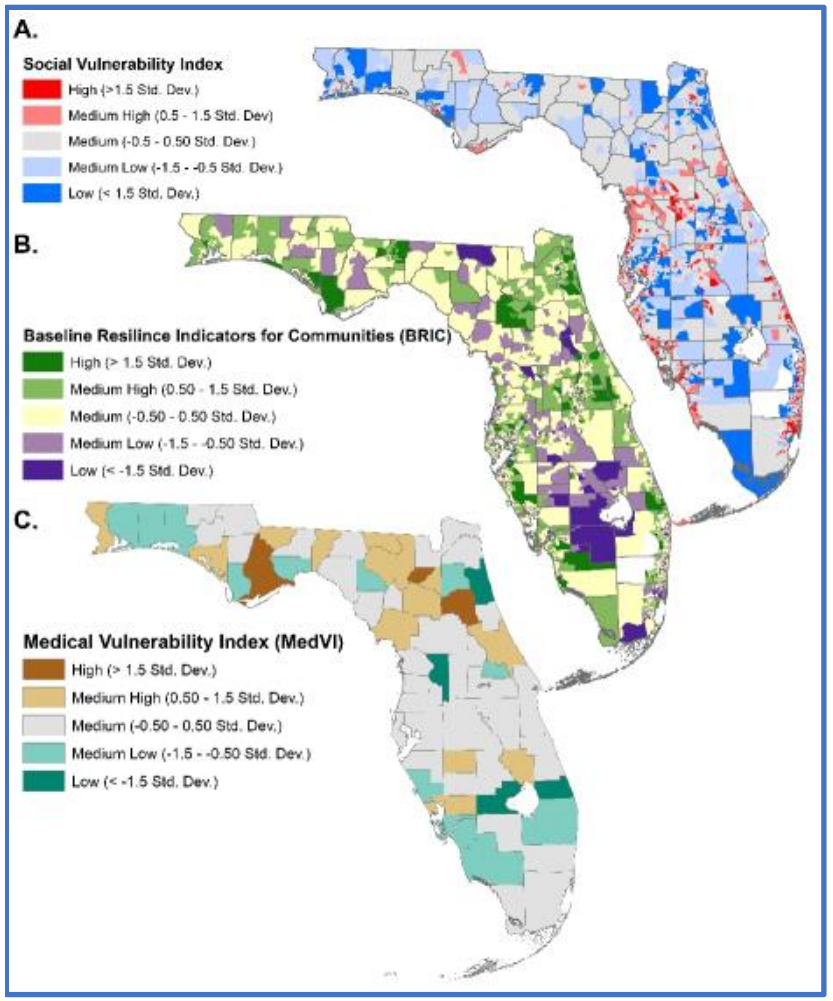
H1: Impacts increase linearly and proportionally as the intensity of the risk event increases.



H2: Impacts of risk events respond nonlinearly as the intensity of the risk event increases.

Two competing hypotheses to explain how intensity of risk events result in social and economic impacts

Science to Practice and Future Generations



Decision Support Tool Development

VMAP VULNERABILITY MAPPING ANALYSIS PLATFORM

www.vulnerabilitymap.org

HazardAware

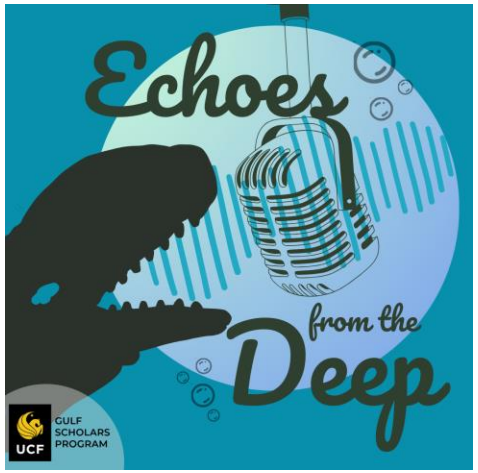
www.hazardaware.org

Mapping R2C Threats & Risks

www.hazardrisk.org

Educational Pipeline

UCF GULF SCHOLARS PROGRAM



Aquatic Biogeochemistry Research

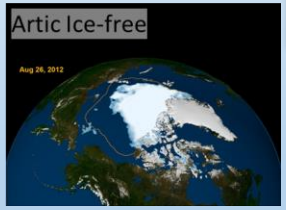
Lisa Chambers, Ph.D.
Associate Professor
Department of Biology
Office: Biological Sciences, BIO420
Email: lisa.chambers@ucf.edu

Aquatic Biogeochemistry Lab (ABL)
Soil and Sediment Lab (SASL)
https://sciences.ucf.edu/biology/abl/

Jing Hu, Ph.D.
Assistant Professor
Department of Civil Environmental and Construction Engineering
Office: Engineering I, 340
Email: jing.hu@ucf.edu

Nature-based Solutions (NBS) Lab
https://sites.google.com/view/hu-research-group

Aquatic Biogeochemistry



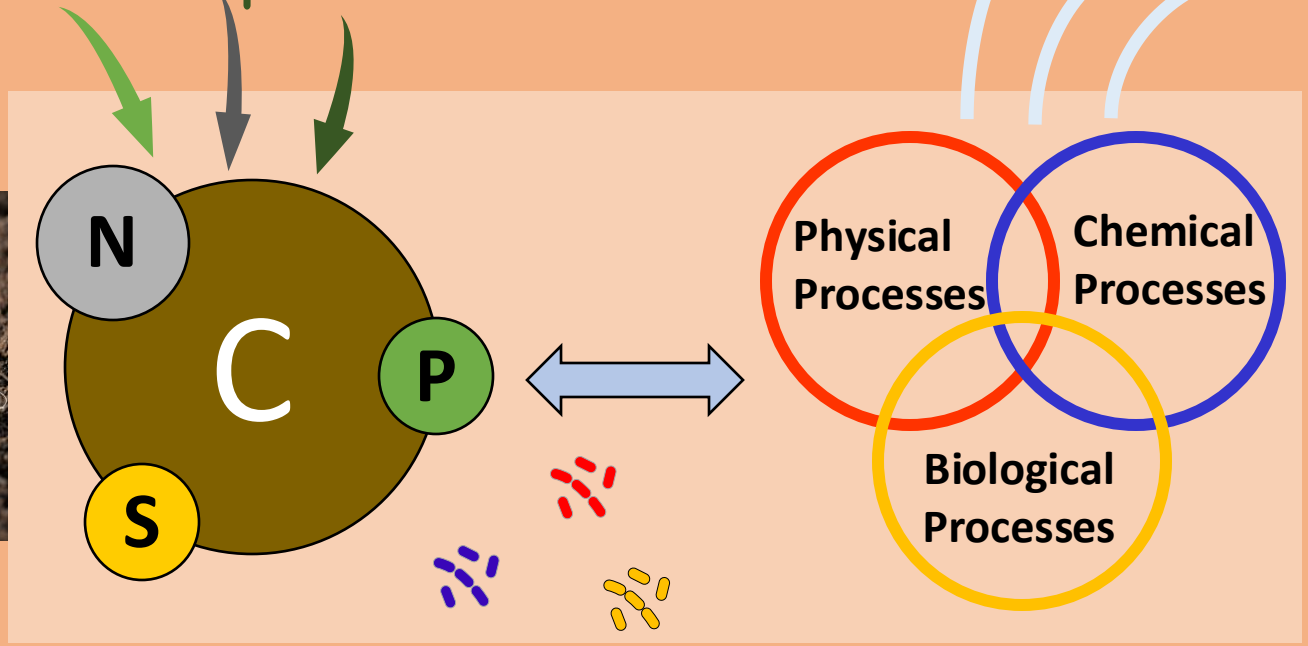
Climate Change

Ecosystem Health & Biodiversity

Anthropogenic Activity

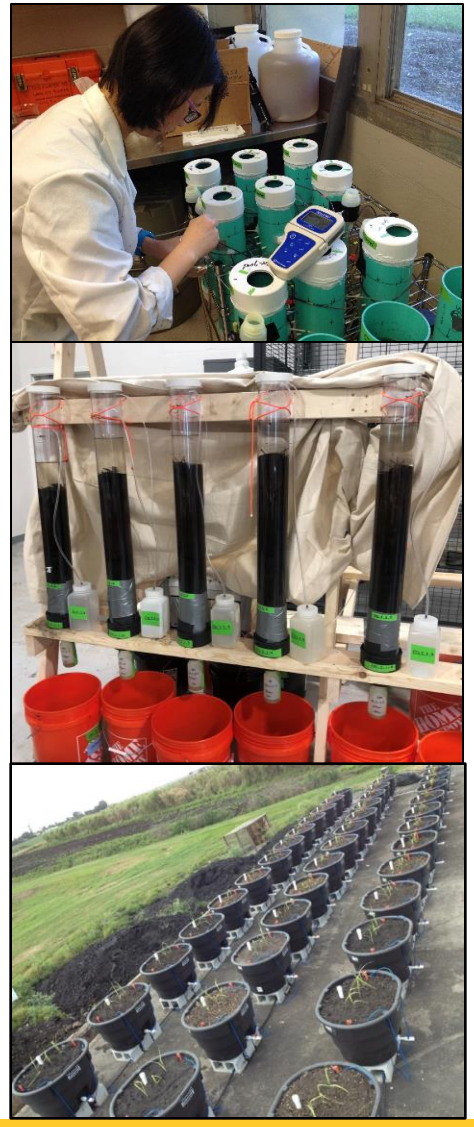
CO_2 N_2O CH_4

Soil Health



Microcosm

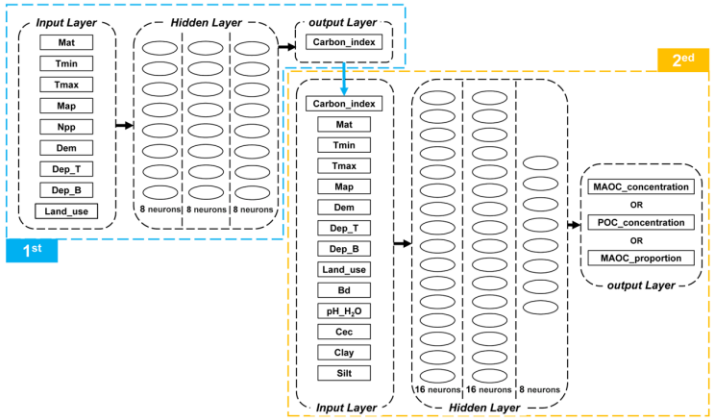
Mesocosm

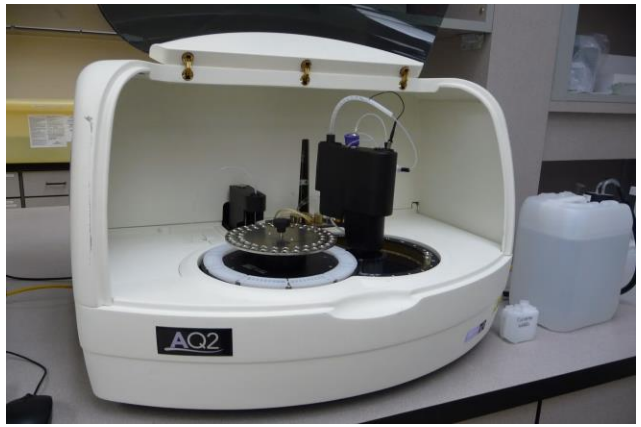


Field Scale

Unmanned Vehicle

Data-driven Model

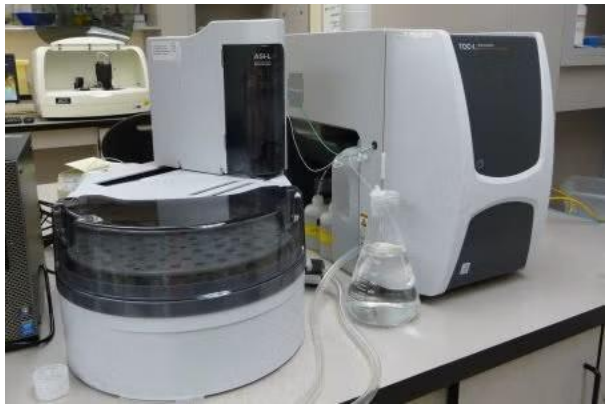




Seal Discrete Water Quality Analyzer

Elementar VarioMicro CN analyzer

Shimadzu Gas Chromatograph



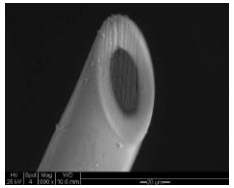
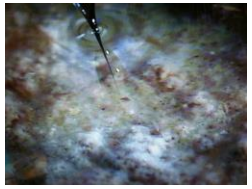
Shimadzu TOC Analyzer

Water Quality and Treatment Research

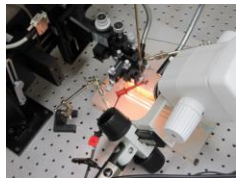
Microsensor Biofilm Research Laboratory at UCF

Electrochemical Microsensor Development

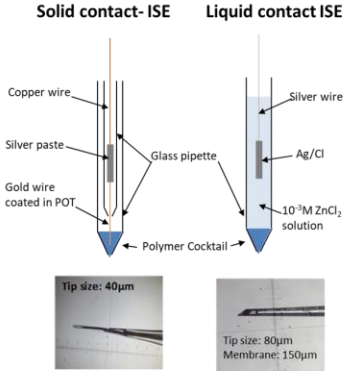
Electrochemical Microsensor Applications

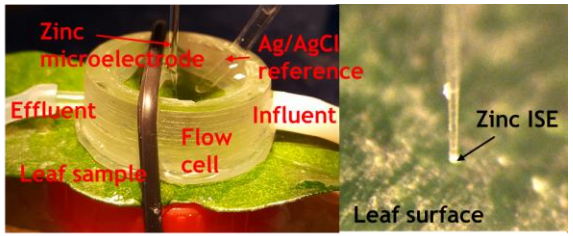



Microelectrodes Microsensors

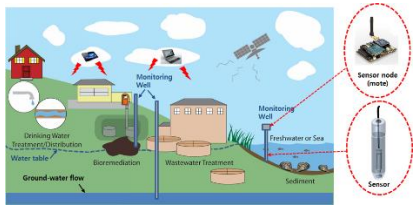
- **Biofilm** → Biofilm kinetics for wastewater treatment; Algae-bacterial biofilm process; Membrane Fouling
- **Reactive Metals** → Drinking Water Pipeline Biofilm Disinfection; Corrosion/ biocorrosion; Reactive oxygen species in photocatalytic reaction (H_2O_2)
- **Emulsions** → Oil-in-water emulsion characterization in bilgewater
- **Plants** → Zn^{2+}, Na^{+}, conductivity monitoring in citrus plants





In situ water quality monitoring sensors

- Heavy metal sensor for groundwater quality monitoring (Pb^{2+}, Zn^{2+}, Cd^{2+}, As^{3+}, etc.)
- Free chlorine sensor for water disinfection
- Renewable Energy (algal biohydrogen production)
- Harmful algal toxins detection sensor (e.g., microcystin) for HAB monitoring
- Ammonium, nitrite, nitrate, and phosphate detection sensors



In situ heavy metal detection sensor

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Microsensor Biofilm Research Laboratory at UCF

Renewable Energy Production from Wastewater

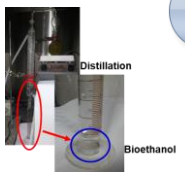
Algal biomass and bioenergy

- Carbon mass tracking
- Biomass production
- Renewable energy production (H_2, biofuel, electricity)
- No mechanical aeration
- Nutrient & oil recovery

SMART wastewater treatment

Biodiesel

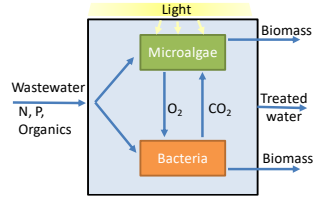
√ Carbon capture from power plants



Bioethanol

Algae

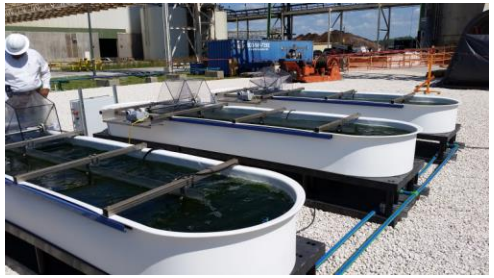
√ Advanced wastewater treatment



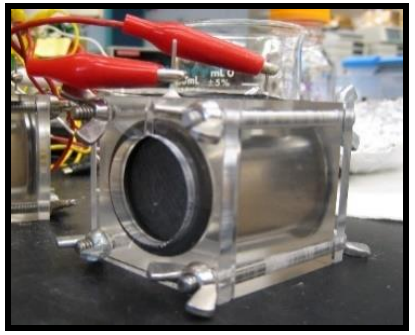
Biogasoline

https://inhabitat.com/first-algae-powered-car-attempts-to-cross-us-on-25-gallons/

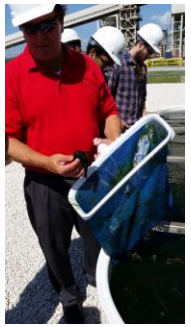
√ Biohydrogen



Carbon balances during algal flue gas utilization at Stanton Energy Center (Orlando, FL)



MFC (electricity generation) or MEC (hydrogen production) for advanced wastewater treatment



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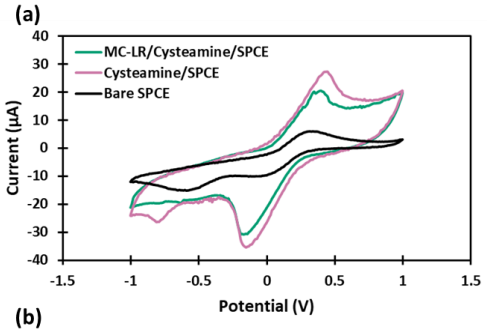
Research Title and Motivation

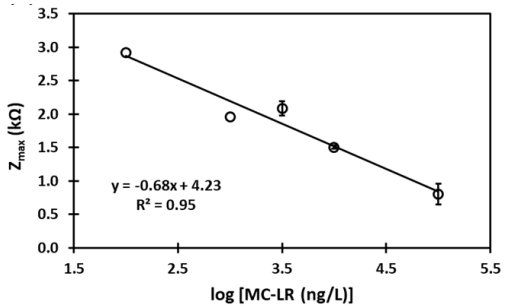
Harmful algal toxin (MC-LR) detection sensor

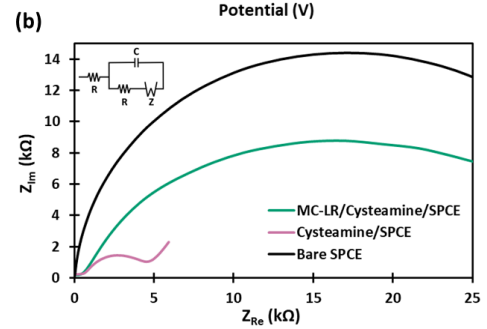
Collaborator: Dr. Lei Zhai (NSTC and Department of Chemistry) and Dr. Keugtae Kim (U of Suwon, Korea)

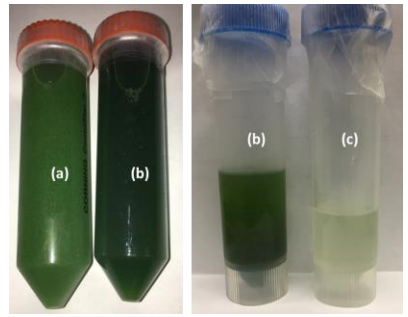
Sponsors and funding agencies: U.S. EPA

- **Monitor the occurrence of HABs and the concentration of cyanotoxins is important to warn people in the area if the level becomes too high.**
- **Traditional methods (LC-MS) have good detection but are time consuming and mostly conducted in a laboratory, requiring expensive equipment and highly trained personnel.**





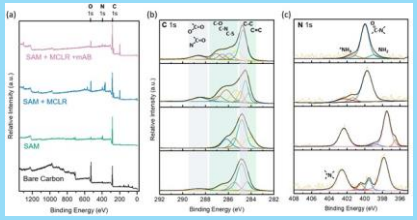


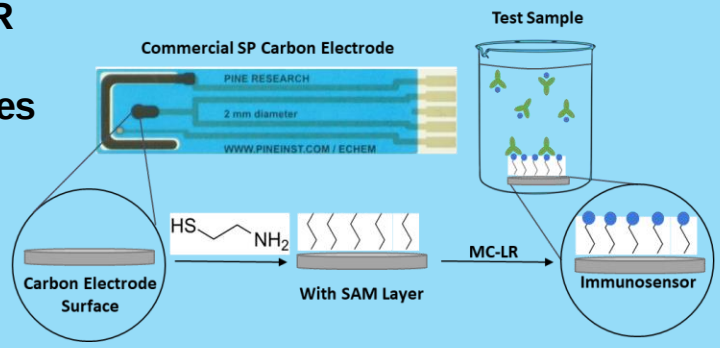


Objectives, Approach

To develop an easily operational, low-cost, and quick method for the determination of cyanotoxins in a natural water systems

- **Fabrication and characterization of Anti-MC-LR/MC-LR/Cysteamine/SPCE**
- **Analysis of Anti-MC-LR/MC-LR/Cysteamine/SPCE**
- **Application to MC-LR detection in real surface water samples**





Impact, Outcomes, Achievements

- **Good linear working range of MC-LR concentrations between 0.1 and 100 μg L^{-1} with a LOD of 0.69 ng L^{-1}.**
- **Natural water samples experiencing HABs were collected and analyzed using the developed biosensor, demonstrating the excellent performance of the biosensor with a relative standard deviation (RSD) of 0.65%.**
- **The biosensor showed acceptable functionality with a shelf life of up to 12 weeks.**
- **The biosensors can be an innovative solution with characteristics that allow for in situ, low-cost, and easy-to-use capabilities which are essential for developing an overarching and integrated "smart" environmental management system.**

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Research Title and Motivation

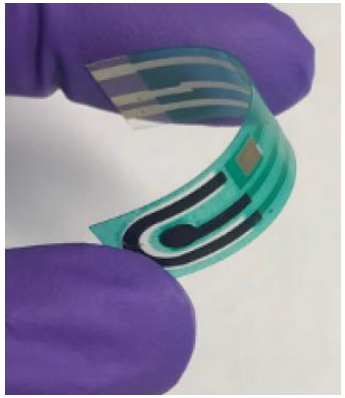
Electrochemical Heavy Metal Detection and Remediation

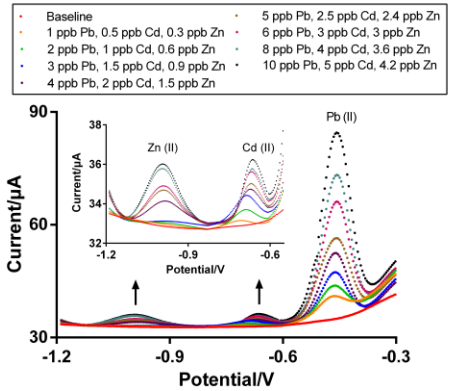
Collaborators

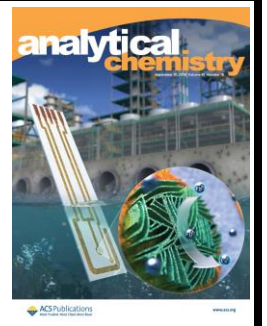
- **MAE: Dr. Hyoung Jin Cho**
- **NanoScience Technology Center (NSTC): Dr. Lei Zhai, Dr. Yeonwoong Jung (MSE)**

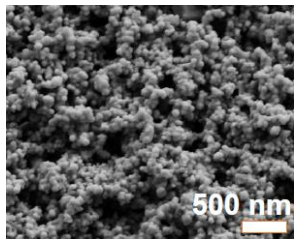
Sponsors and funding agencies: U.S.EPA, Savannah River Nuclear Solutions LLC (SRNS), RM Tech, Neogen

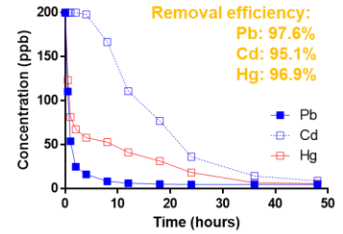
Contamination by heavy metals in drinking water, mining wastewater has gained increasing public attention due to their impact on public health and ecosystems











Objectives, Approach

Chitosan as a biopolymer → improving sensitivity by absorbing heavy metals, to form stable chelates with many transition metal ions through its hydroxyl and amino groups

Investigate a systematic strategy for detecting various heavy metal ions (Pb^{2+}, Zn^{2+}, Hg^{2+}, Cd^{2+}, As^{3+}) using nanotechnology

- **to study the optimization of the deposition time, frequency, and amplitude for detecting metals**
- **to evaluate the sensor performance including calibration curves, limit of detection (LOD), and lifetime**
- **to investigate the sensitivity and reproducibility of sensor for detecting heavy metal using SWASV method**

Impact, Outcomes, Achievements

Development of various heavy metal detection sensors for water quality monitoring

- **A novel copper-chitosan coated share conformable electrochemical sensor for trace level detection of lead ions**
- **A novel bismuth-chitosan nanocomposite sensor for simultaneous detection of Pb(II), Cd(II) and Zn(II) in wastewater**
- **Improving electrochemical Pb^{2+} detection using a vertically-aligned 2D MoS_2 nanofilm**
- **A novel Fe-Chitosan-coated carbon electrode sensor for *in situ* As(III) detection in mining wastewater and soil leachate**

Electrochemical heavy metal removal and recovery by collaborating nanotechnology experts

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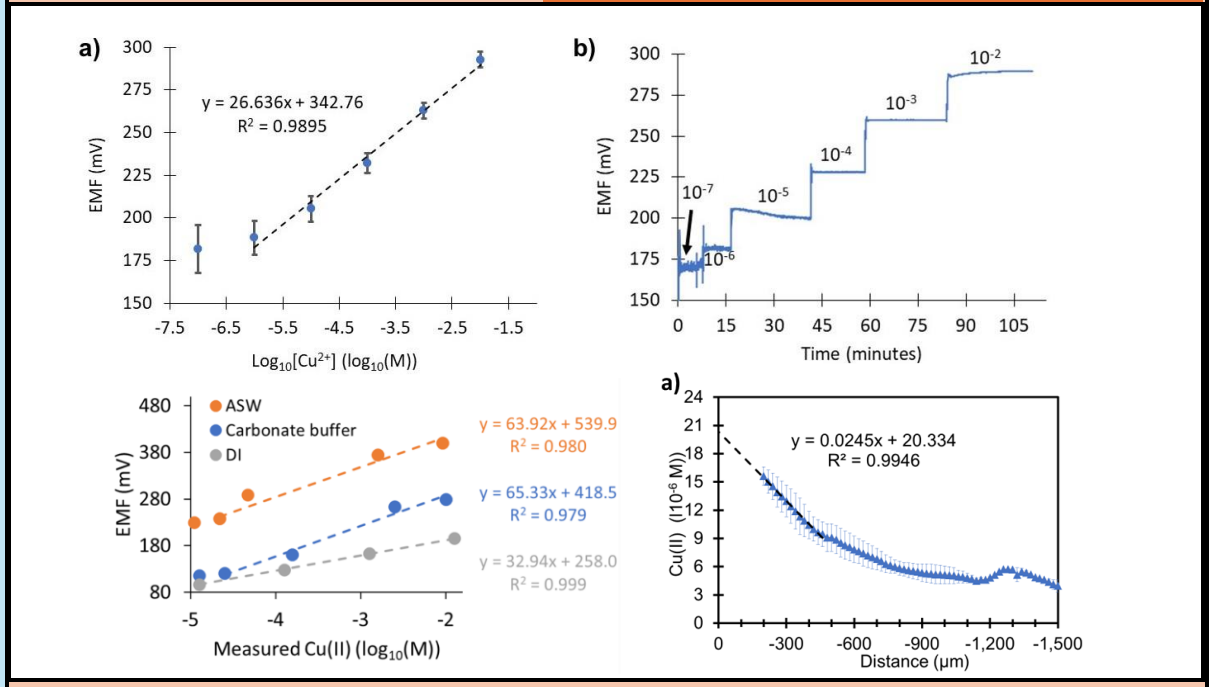
Research Title and Motivation

Ion-selective microelectrode (ISME) sensor for monitoring copper in seawater-like solutions

Collaborator: Dr. Chumbimuni-Torres (UCF Department of Chemistry)
Sponsors and funding agencies: ONR Summer Faculty Program

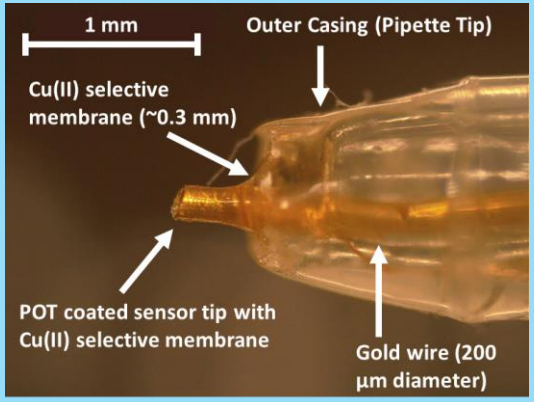
Leaching of Cu(II) ions from copper surfaces in marine environments, such as antifouling-painted ships, can harm marine ecosystems. Adversely, high copper exposure could result in gastrointestinal distress and long-term liver or kidney damage.



Objectives, Approach

To develop a novel Cu(II)-ISME using a polymeric Cu(II) ion selective membrane and characterize for *in situ* measurements at the microscale in seawater-like solutions.

- **Fabricate the Cu(II)-ISME sensor.**
- **Determine the selectivity of the sensor against common ions (K^+, Na^+, Mg^{2+}, and Ca^{2+})**
- **Characterize the sensor performance in seawater-like and buffer solutions**
- **Perform microprofiles at the copper coupon surface in various water conditions**



Impact, Outcomes, Achievements

- **Good Nernstian response in DI water with a linear slope of 26.6 mV/decade, low response time (<30 seconds) and low LOD of 1×10^{-6} M Cu(II) (0.064 ppm).**
- **Sensor response in artificial seawater (ASW) maintained a Nernstian response, though with some effect on sensor of LOD of 1.6×10^{-5} M Cu(II) (1.02 ppm).**
- **Microprofiles conducted using the Cu(II)-ISME sensors showed detectable release of Cu(II) from copper coupons in DI water.**
- **The Cu(II)-ISME sensor can be an innovative solution for characterizing Cu(II) release and the microprofile results indicate the feasibility for application in drinking water pipe corrosion and Cu(II) anti-fouling paint release.**

19

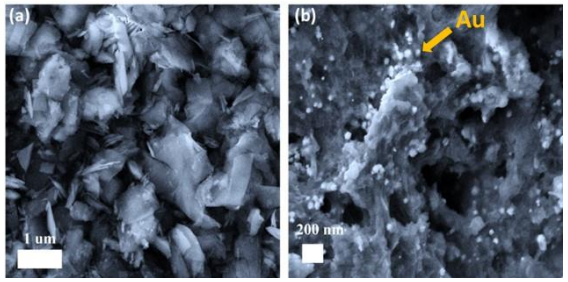
Research Title and Motivation

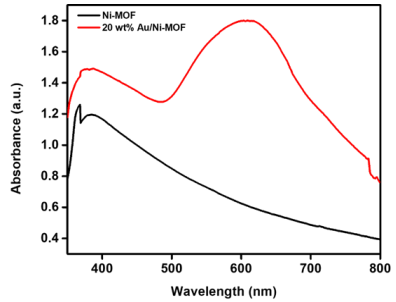
Advanced photodegradation of harmful algal toxin (MC-LR)

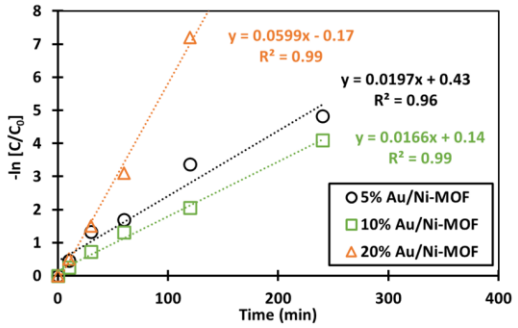
Collaborator: Dr. Yang Yang (NSTC and Department of Material Science and Technology)

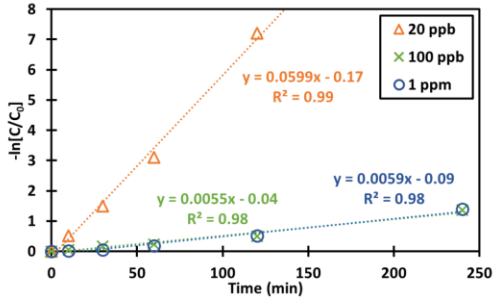
Sponsors and funding agencies: U.S. EPA

- **Microcystins (MCs) are toxins produced by cyanobacteria commonly found in HAB occurring in many surface waters.**
- **Conventional methods for removing MC-LR such as membrane filtration and activated carbon are only phase change removal methods and are often expensive in operation and maintenance.**





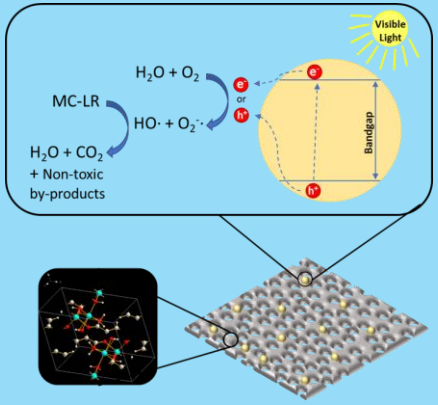


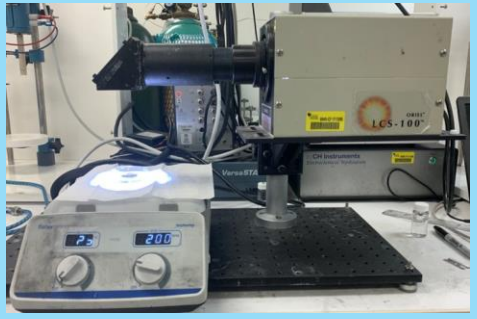


Objectives, Approach

To develop a rapid, easy-to-use, and cost-effective method for the degradation of MC-LR.

- **Solar-driven photodegradation of MC-LR using a novel Au-decorated Ni metal-organic framework (Au/Ni-MOF)**





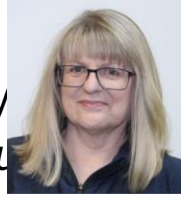
Impact, Outcomes, Achievements

- **The developed MOF materials have a high surface area to efficiently trap the contaminant molecules such as MC-LR.**
- **The usage of Au can boost the hot carriers generation rate that provides improved kinetics for the surface reactions of contaminant degradation.**
- **Photocatalytic degradation of contaminant can be applied on-site when using Au/Ni-MOF, which is more convenient and effective.**
- **The Au/Ni-MOF has shown to be a good catalyst for the photodegradation of MC-LR → can be implemented into a drinking water treatment facility with surface water as the source to remove the MC-LR prior to disinfection.**

20

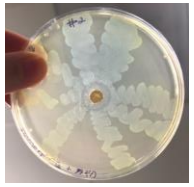
Beazley Research Laboratory
Environmental Analytical Chemistry & Microbiology

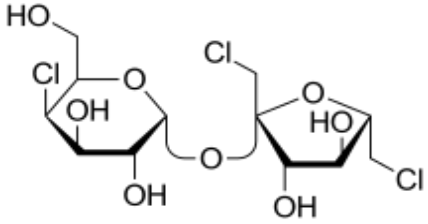
Melanie J. Beazley, Ph.D.
Department of Chemistry
Melanie.Beazley@ucf.edu

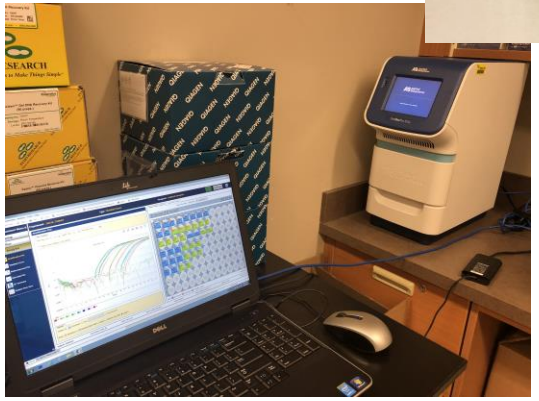


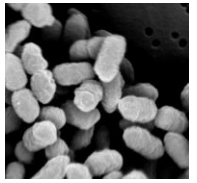
Current Projects

- Stormwater Biogeochemistry and Nutrient Cycling
- Effects of Excess Nutrients on Area Lakes, Streams
- Contaminant Bioremediation
- Wastewater-based Epidemiology (Covid, Flu)
- Microbial Source Tracking/Metagenomics
- Phosphorus Cycling in Sediments
- Microbial Ecology









Water Quality Engineering Research

Potable supply, treatment, distribution and storage water quality and process engineering.

Dr. Steve Duranceau, P.E.
(Florida)

Gerry & Ruth Hartman Professor of Environmental Engineering

UCF Dept. of Civil, Env. & Construction Engineering

Director Environmental Systems Engineering Institute

City of Sarasota, FL
Reverse Osmosis Process Room
Engineer-of-Record
S.J. Duranceau. P.E. 46583

Representative Funding Organizations (Since 2007)

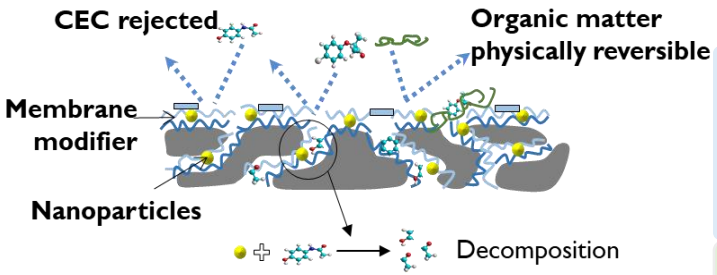
- **Georgia**
  - *Butts County Water & Sewer Authority*
- **California**
  - *Alameda County Water District*
- **Hawaiian Islands**
  - *County of Maui Water Supply*
  - *Pulama Lana'i Water*
  - *Kauai Wai'ahi Supply-Aqua Engineering*
- **Marianas Islands**
  - *U.S. Navy COMNAVMARIANAS, Guam, U.S.A.*
- **Federal Agencies**
  - *U.S. Department of Agriculture*
  - *National Science Foundation*
- **Other:**
  - *Water Research Foundation Projects:*
    - *Bahamas*
    - *Belize*
    - *Cayman Islands*
  - *Jones Edmunds Fund (Research Foundation)*
- **Florida**
  - *City of Boynton Beach*
  - *City of Clearwater*
  - *City of Delray Beach*
  - *City of Dundee*
  - *City of Haines City*
  - *City of Oviedo*
  - *City of Palmetto*
  - *City of Sarasota*
  - *City of Winter Springs*
  - *Lake Utility Service District*
  - *Manatee County*
  - *Orange County*
  - *Polk County*
  - *Sarasota County*
  - *Tampa Bay Water*
  - *Town of Jupiter*
  - *Wedgefield*

Water/Wastewater Treatment

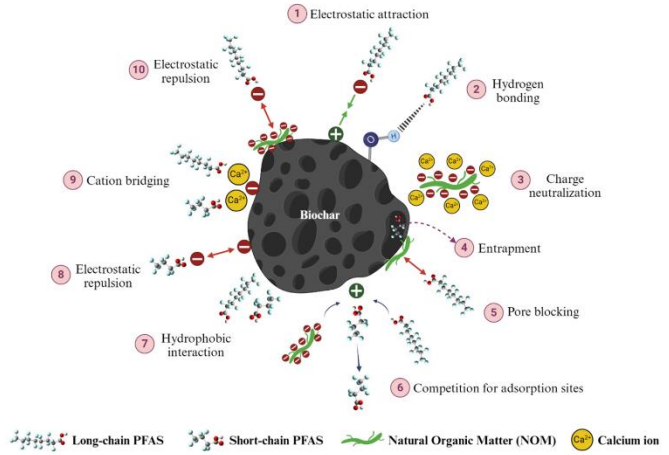
A H M Anwar Sadmani, Ph.D., P.Eng.; Associate Professor
Advanced Water and Wastewater Treatment Lab (https://www.cece.ucf.edu/person/anwarsadmani/)
Stormwater Management Academy (https://stormwater.ucf.edu/)

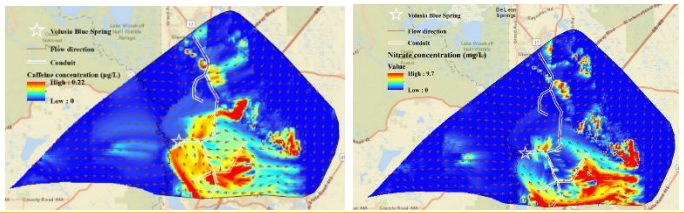
Research Area

- Membrane treatment of contaminants of emerging concern (CEC)
- Membrane fouling mitigation
- Membrane-based hybrid processes for treating impaired quality waters
- CEC removal using novel sorbents
- Remediation of CECs in environmental matrices
- Fate and transport of CECs and other contaminants in environmental media



"All-rounder" membranes





Example Projects

- Enhanced removal of perfluoroalkyl and polyfluoroalkyl substances (PFAS) via functionalized membranes
- Removing heavy metals from landfill leachate using polyelectrolyte fiber mat-laminated membrane
- Water reclamation using nanoparticle-enhanced Forward Osmosis membrane
- High-capacity sorbents for PFAS treatment
- Low-cost, sustainable sorbents to remediate nutrient and PFAS pollution
- Modified biochar-integrated hybrid treatment processes to remove PFAS
- Modeling nutrient and CEC transport in Karst aquifer
- Rapid detection and forecasting of algal toxins in inland and coastal waters

Funding Agencies: SERDP DOD • EPA • DOE; Hinkley Center for Solid and Hazardous Waste Management; Sea Grant Florida; United States Environmental Protection Agency; Florida Department of Environmental Protection; NASA Florida Space Grant Consortium; Fish & Wildlife Foundation of Florida; ecs Environmental Conservation Solutions

Hydrology and Fluvial Geomorphology Research

Hydro-Geomorphology Group (Dr. Arvind Singh)

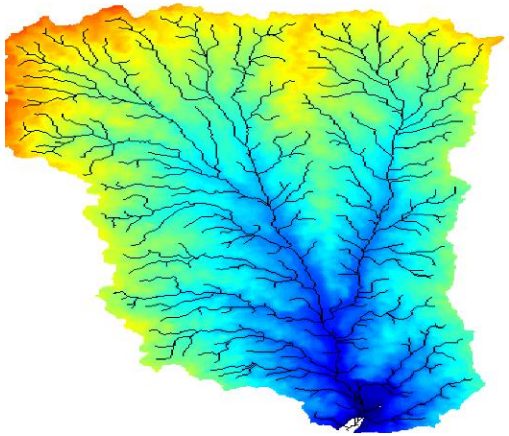
https://sites.google.com/site/singhsedtrans/home

Hurricane Sandy, NOAA

Research Area: Impact of climate change and anthropogenic activities on hydrology and geomorphology

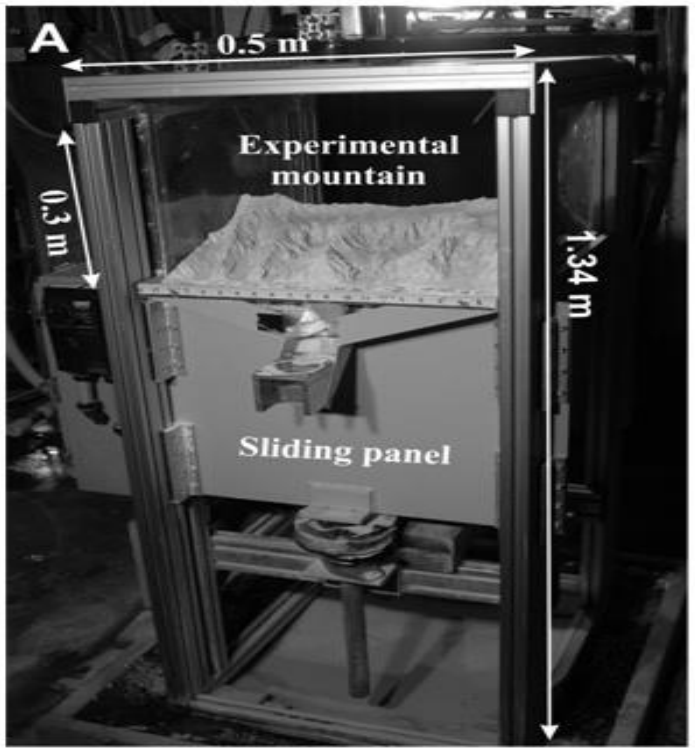
Interests/Expertise:

- River Hydraulics & Hydrology
- Sediment Transport
- Geomorphology
- Fluid Mechanics



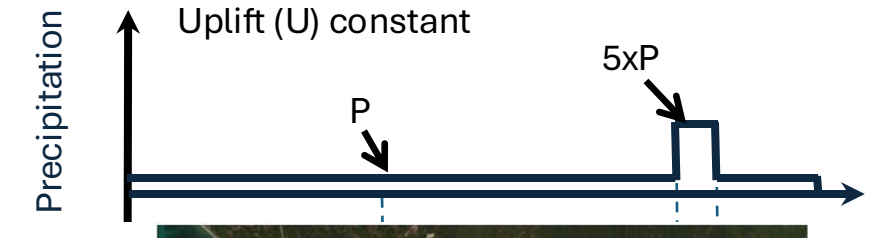
Source:www.illaheecommunity.com

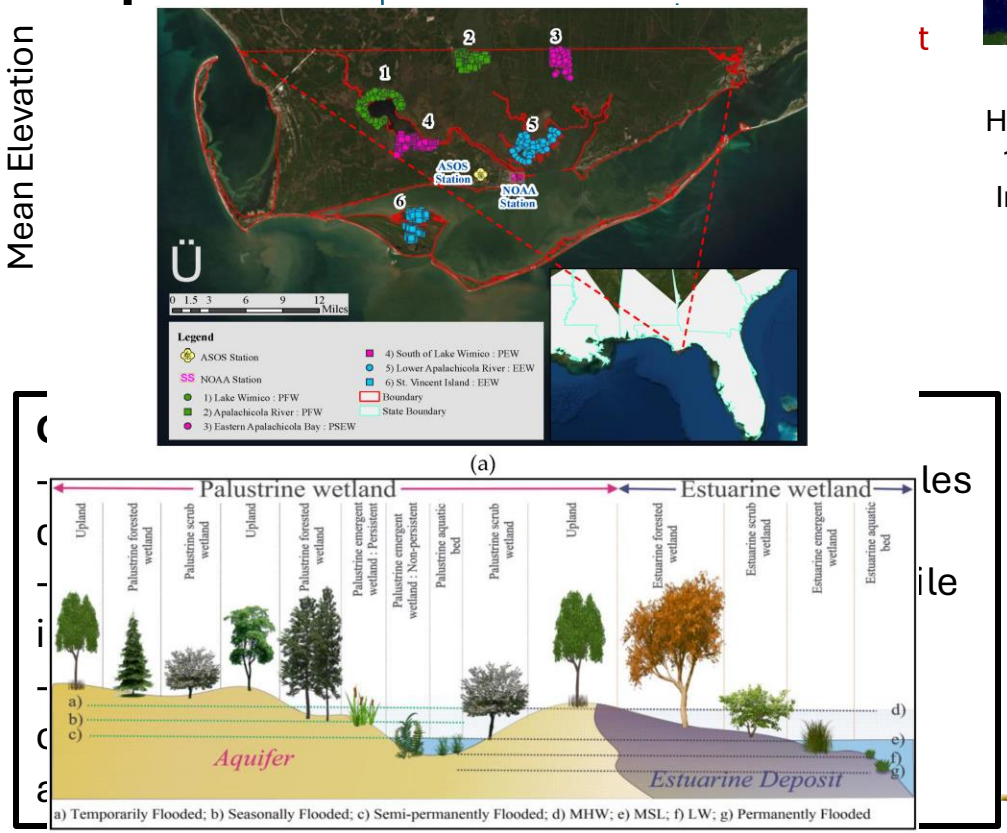
Interaction of turbulence, topography and transport: Implications toward understanding response of landscape to changing precipitation



➢Erosion box : 0.5 X 0.5 X 0.3 m^3

[Singh et al., WRR, 2015; Tejedor et al., Sci. Adv. 2017; Hooshyar et al., GRL, 2019]

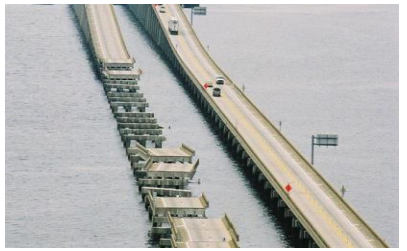




[Tahsin et al. 2016;2018;2020

Flood Hazard + Infrastructure

Satellite Image of Hurricane Ivan September 15, 2004, 11:15 AM EDT. Image Courtesy of NOAA



I-10 Bridge across Escambia Bay After Hurricane Ivan, 2004. Image Courtesy of Kiewit.com

Applications:

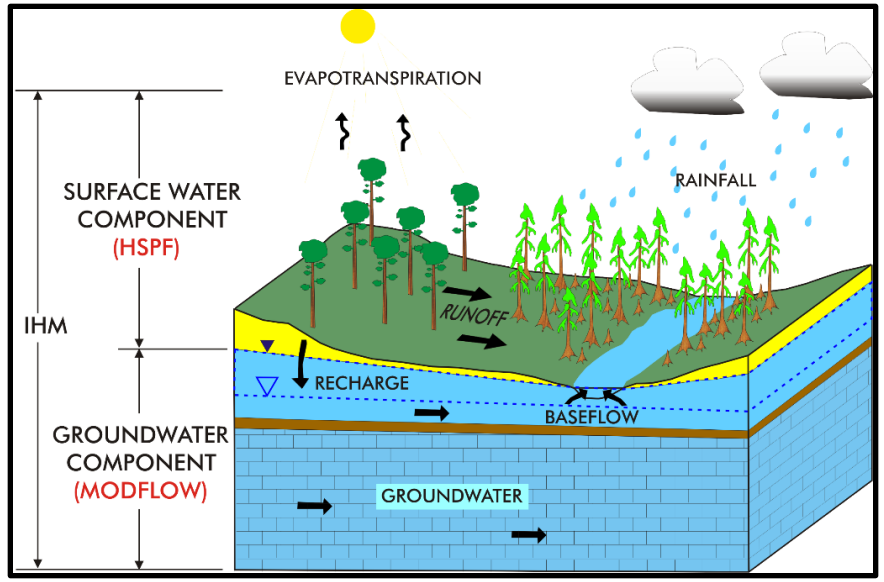
- Predictive modeling of landscape reorganization under changing climate
- Storm-water management
- Response of wetlands to changing hydrologic forcings

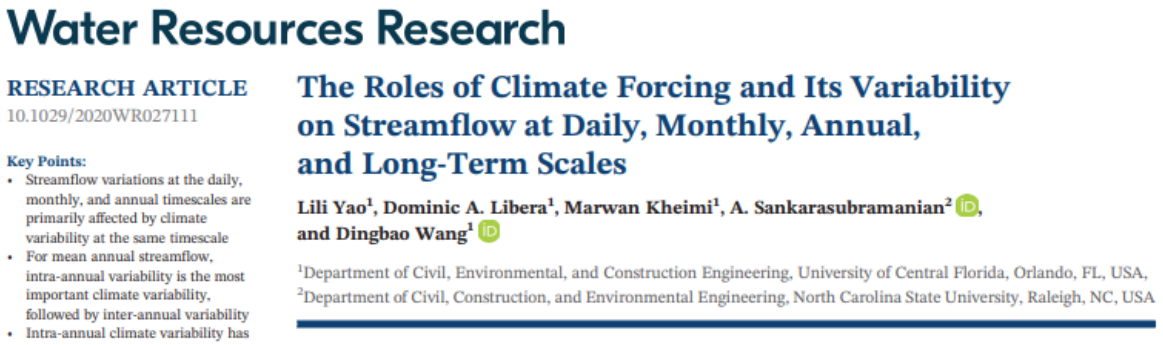
Hydrology Group (Dr. Dingbao Wang)

Hydrologic modeling

- Unifying hydrologic models across time scales (long-term, monthly, and event scales)
- Integrated surface water and groundwater modeling
- Climate and process controls on hydrologic fluxes (e.g. groundwater recharge and evapotranspiration, inter-basin groundwater flow)

Funded by Tampa Bay Water





Water Resources Research

RESEARCH ARTICLE
10.1029/2020WR027111

The Roles of Climate Forcing and Its Variability on Streamflow at Daily, Monthly, Annual, and Long-Term Scales

Key Points:
- Streamflow variations at the daily, monthly, and annual timescales are primarily affected by climate variability at the same timescale
- For mean annual streamflow, intra-annual variability is the most important climate variability, followed by inter-annual variability
- Intra-annual climate variability has

Lili Yao[1], Dominic A. Libera[1], Marwan Kheimi[1], A. Sankarasubramanian[2], and Dingbao Wang[1]

[1]Department of Civil, Environmental, and Construction Engineering, University of Central Florida, Orlando, FL, USA, [2]Department of Civil, Construction, and Environmental Engineering, North Carolina State University, Raleigh, NC, USA

Water Resources Research

RESEARCH ARTICLE
10.1029/2024WR037248

A Three-Stage Partitioning Framework for Modeling Mean Annual Groundwater Evapotranspiration

Key Points:
- Mean annual groundwater evapotranspiration (GWET) is modeled by analytical equations through a three-stage partitioning framework
- Mean annual GWET increases initially and then declines with increase in

Fanzhang Zeng[1], Yu Zhang[1], Jeffrey S. Geurink[2], Kshitij Parajuli[2], Lili Yao[1,3], and Dingbao Wang[1]

[1]Department of Civil, Environmental, and Construction Engineering, University of Central Florida, Orlando, FL, USA, [2]Tampa Bay Water, Clearwater, FL, USA, [3]Now at Pacific Northwest National Laboratory, Richland, WA, USA

UCF

Thank you!

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