

INTERCOH 2026 Abstracts

ORAL PRESENTATIONS

Bhoobun, Chitrachandika Deepika^{1*}, Florent Grasso¹, Romaric Verney¹

A Numerical Study of the Interactions Between Intertidal Mudflat Morphodynamics and Tidal Creek Development

¹IFREMER; *cbhoobun@ifremer.fr

Intertidal mudflats are coastal wetlands between high and low tides, providing essential habitat, storing sediments, and offering natural coastal protection. These systems face increasing threats from sea-level rise, altered sediment supply, and human activities, motivating the need to better understand their long-term evolution. Tidal creek networks, common within mudflats, act as main pathways for water and sediment exchange, influencing morphology, sediment dynamics, and nutrient cycling. While mudflats and tidal creeks have each been studied and modeled independently, most mudflat models rely on two-dimensional cross-shore representations and do not account for tidal creek networks, limiting the ability to predict their coupled evolution. This study investigates the hydro-morpho-sedimentary evolution of intertidal mudflats by integrating multi-scale morphological structures to explore how they may evolve over time. Numerical simulations were performed using the coupled CROCO–MUSTANG modeling system, in which CROCO resolves hydrodynamics and MUSTANG computes sediment transport and bed evolution. Creek initiation was simulated by introducing small topographic perturbations (<1 cm) into an initially smooth bathymetry, following previous studies showing that micro-depressions focus flow and enhance erosion, enabling natural creek formation. Simulations represent 20 years of evolution under a macrotidal regime (8-m) with cohesive sediment on a 500×1500-m domain with 5-m grid resolution. These simulations aim to capture generic morphodynamic behaviour rather than reproduce a specific site. Model validation is performed using COSMOS (Characterisation Of bed Structure MORphologies and Spacing), a structural analysis tool developed in this study to quantify tidal creek geometry, including width and depth. Comparisons indicate that simulated creek networks reproduce key structural characteristics consistent with field observations from a large mudflat in the Seine Estuary (France). A series of typology simulations was conducted to explore the influence of upper-flat geometry, including slope, length, and elevation relative to mean sea level, on creek development and long-term mudflat evolution. Preliminary results focusing on slope, using a 1000 m-long upper flat revealed non-linear, slope-dependent patterns: a very gentle slope favoured a single large, deep creek; intermediate slopes produced either multiple smaller creeks or one main creek; and a very steep slope limited creek development, indicating a threshold beyond which creek formation is restricted. Cross-shore profiles show that morphological change was greater on gentler

slopes, highlighting the control of initial bed geometry on long-term mudflat evolution. These findings provide a framework for understanding the coupled evolution of intertidal mudflats and tidal creek networks under varying tidal ranges, sediment types, and environmental pressures.

PhD Student

Chang, Jongwi^{1*}, Courtney K. Harris¹, Kehui Xu², Jacob Reinhardt²

Evaluating the Role of Seabed Consolidation in Resuspension Dynamics: 1D Modeling Study for the Mississippi River Subaqueous Delta

¹Virginia Institute of Marine Science; ²Louisiana State University; *jchang@vims.edu

Predicting the long-term fate of fluvial mud in river-dominated subaqueous deltas requires accurate seabed process representation. Sediment from riverine sources undergoes several resuspension, transport, and redeposition cycles before reaching ultimate depositional locations. Mud erodibility depends on its depositional history and dewatering. Existing models often struggle to represent the evolving erodibility of newly deposited layers, failing to capture the dynamic feedback between consolidation and resuspension. This limitation is pronounced during episodic forcing, where neglecting a consolidation framework leads to an incomplete understanding of how erodibility modulates sediment transport and stratigraphic preservation.

Therefore, this study investigates seabed consolidation's role in regulating resuspension and deposition during high-energy events in East Bay, Louisiana. East Bay is a shallow (5–20 m depth), triangle-shaped interdistributary bay between the Southwest and South Passes of the Mississippi Birdfoot Delta, characterized by high mud content and rapid accumulation ($\sim 22 \pm 4$ cm/year). To evaluate disparities in erosion thresholds (τ_{cr}) and resuspension depths, we compared consolidated and non-consolidated bed scenarios using a 1D (vertical) ROMS/CSTMS configuration.

Model inputs were derived from hourly observations using tripod-mounted acoustic sensors at 5 m and 10 m depths during the winter and spring of 2024. These captured high-energy events where easterly winds (>10 m/s) generated significant wave heights (>1 m) and suspended sediment concentrations (SSC) of 1–10 g/L. To evaluate hydrodynamic performance, TKE-derived shear stresses (1–6 Pa) were compared against modeled stresses. Next, resuspension was calculated using two distinct erosion frameworks. The first scenario represents a non-cohesive bed where τ_{cr} depends on grain size and remains constant regardless of age or depth. In contrast, the second scenario used a consolidated cohesive bed model where τ_{cr} evolves as a temporally and vertically varying profile, reflecting consolidation and reduced erodibility over time. Parameterization was based on previous erosion chamber measurements from the Mississippi delta.

Results indicated that bed consolidation fundamentally altered resuspension dynamics by establishing a vertical τ_{cr} gradient. In the consolidating model, the rapid

τ_{cr} increase with depth effectively limits erosion to a thin, uppermost layer. Conversely, the non-cohesive model exhibited deeper resuspension due to lack of internal strengthening. Modeled SSC were directly compared to tripod-measured values, demonstrating that the consolidation framework more accurately represents sediment budgets in this energetic, muddy setting. This study serves as a benchmark for sediment retention in shallow bays, with implications for coastal restoration in Louisiana.

Du, Rongqing^{1*}, Kehui Xu¹, Z. George Xue¹, Yanda Ou¹, Ehab Meselhe², Kelin Hu², Courtney K. Harris³, Jongwi Chang³

From Plume Dispersal to Bed Consolidation: Modeling Sediment Dynamics on the Mississippi River Delta Front

¹Louisiana State University; ²Tulane University; ³Virginia Institute of Marine Science, William & Mary; *rdu@lsu.edu

Sediment delivery from the Mississippi River is fundamental to the maintenance and evolution of the Mississippi River Delta Front (MRDF), where plume dynamics, deposition, and post-depositional seabed change together influence the delta stability. This study investigates how varying physical forcing, including river discharge, wind, and wave, affects the transport and deposition of sediment on the MRDF. Attention is given to fine-grained sediment behavior and seabed consolidation, which helps determine whether newly delivered sediment is deposited, remobilized, or reworked under changing hydrodynamic conditions.

A 400 m horizontal resolution, three-dimensional hydrodynamic-sediment transport modeling framework is being developed. Using the COAWST modeling system, the framework integrates the Regional Ocean Modeling System (ROMS) with riverine and oceanic boundary forcings to simulate hydrodynamics and sediment transport processes under various conditions. Ocean boundary conditions are provided by a larger Gulf model, while river discharge is supported by a model focusing on the lowermost river channel and delta outlets. The sediment framework represents both cohesive and non-cohesive sediment classes together with evolving multi bed layers, allowing erosion, deposition, and seabed adjustment to be examined simultaneously through time.

The simulation period extends from summer 2024 to summer 2025, covering a range of weather and discharge conditions as well as multiple coring field trips. The model is used to examine how fair-weather conditions, high river discharge, and storms control sediment dispersal, deposition and erosion across the delta front and adjacent shelf. This framework also supports comparison with field observations, including geophysical measurements and sediment core data, to evaluate model performance and improve representation of sediment transport processes. By incorporating cohesive bed consolidation module and its associated changes in erodibility with historical data collected using a Gust Erosion Microcosm System, this work advances toward a more

realistic description of delta-front sediment transport and bed evolution, with implications for understanding the present condition and future trajectory of the Mississippi River Delta under changing hydrodynamics and climatic forcings.

PhD Student

Du, Zhiyun^{1*}, Courtney K. Harris¹, Steven A. Kuehl¹

Contrasting Suspended and Gravity-Flow Sediment Transport on the Ayeyarwady–Thanlwin Shelf

¹Virginia Institute of Marine Science, William & Mary, Gloucester Point, VA 23062, USA; *zdu@vims.edu

The combined discharges of the Ayeyarwady–Thanlwin Rivers (A–T) constitute the world’s third-largest riverine sediment source to the coastal ocean, discharging an estimated ~485 Mt of sediment annually to the northern Andaman Sea. The western offshore shelf area includes a subaqueous delta ramp south of mouths of the Ayeyarwady distributaries. To the east lies the shallow Gulf of Martaban, a large funnel shaped embayment, which deepens seaward to the Martaban Depression, a pull-apart basin forming along the Sagaing fault. A 2017 field campaign, including seabed mapping and sediment core analysis, revealed a muddy clinoform depocenter extending from the Gulf to the Martaban Depression. Based on geochronology from sediment cores, peak accumulation rates of ~6 cm/yr were seen in water depths of 50–80 m. Before delivery to this depocenter, however, riverine sediment dispersal is regulated by oceanographic conditions including seasonal monsoon-driven waves and coastal circulation. During the summer monsoon, southwest winds bring high precipitation and cause energetic waves, while the winter monsoon is dry with moderate winds and waves. Sediment dispersal is also influenced by energetic tides with a strong spring-neap variation in this macrotidal system. For example, the Gulf of Martaban has a tidal range that reaches 7 m.

A three-dimensional, time-dependent numerical model based on the Coupled Ocean–Atmosphere–Wave–Sediment Transport modeling platform has been developed to investigate the transport mechanisms that deliver sediment to the depocenter. The model incorporates river discharge, tides, wind forcing, wave dynamics, and open boundary conditions. Simulation spans 2006 to June 2008, including a non-storm year (2007) and two major storms: Cyclone Mala (April 2006) and Cyclone Nargis (May 2008). Two numerical experiments were conducted: one that represented dilute suspended-load transport only, and another that represented wave- and current-supported gravity-flow transport.

Results from the suspended-load simulation show that sediment export from the Gulf of Martaban was primarily directed toward the Martaban Depression and was enhanced during the summer monsoon. However, the seaward bottom suspended sediment flux near the clinoform depocenter was negligible even during spring tides and the two major cyclone events. In contrast, wave- and current-supported gravity-flow

transport shows high sediment flux in the vicinity of the clinoform depocenter. Analyses demonstrate that near-bed currents dominated the gravity-flow transport magnitude under non-storm conditions, being highest during spring tides. During Cyclone Nargis, wave orbital velocity played a more important role in driving the gravity-flow transport, but tidal currents were still important for these transports. These results suggest that wave- and current-supported gravity-flow transport represents a key pathway for sediment delivery to the depocenters on energetic muddy shelves.

PhD Student

Eun, Chae Yeon^{1*}, Su In Kim¹, Yong Hoon Kim², Jae-Hun Park¹, Pyeong Joong Kim³, Ho Kyung Ha

Spatiotemporal Variability of Sediment Transport Induced by Tidal Forcing Under Well-Mixed Conditions in a Meso-Tidal Environment

¹Department of Ocean Sciences, Inha University, Incheon, Republic of Korea; ²Department of Earth and Space Sciences, West Chester University of Pennsylvania, West Chester, PA, USA; ³Blue Headquarters, Underwater Survey Technology 21, Incheon, Republic of Korea; *chaeyeeun@gmail.com

Sediment transport in coastal bays is strongly influenced by tidal forcing and water column stratification, which together regulate estuarine circulation and vertical mixing processes. In meso-tidal environments, tidal currents play a dominant role in controlling sediment resuspension and redistribution, therefore, understanding how tidal mixing influences suspended sediment transport over tidal cycles is essential. To investigate sediment transport patterns and stratification over tidal cycles, a comprehensive analysis combining shipborne surveys and mooring observations using acoustic Doppler current profilers (ADCPs) was conducted in Yeosu Bay, Korea. The study area is a meso-tidal bay influenced by seawater inflows and freshwater discharge from the Seomjin River. The main channel of the bay serves as the primary passage connecting to Gwangyang Bay, an industrialized embayment known for sediment contamination. The bed sediments are mainly composed of fine-grained sediments ($d_{50} = 10\text{--}13\ \mu\text{m}$), with silt fractions exceeding 73%. During the observation period, the vertical density structure differed between spring and neap tides, with the surface-bottom density difference remaining negligible ($<1\ \text{kg m}^{-3}$) during spring tide but increasing to $3\ \text{kg m}^{-3}$ during neap tide. These results indicate relatively well-mixed conditions during spring tide compared to neap tide. During spring tides, the Y-shaped bottom topography induced converging (landward) flow during flood tide and diverging (seaward) flow during ebb tide (flood: $0.69\ \text{m s}^{-1}$; ebb: $0.71\ \text{m s}^{-1}$ on average). Under the well-mixed conditions during spring tide, suspended sediment concentrations exhibited clear tidal variability with enhanced resuspension reaching up to $390\ \text{mg l}^{-1}$ near the central part of the main channel. Correspondingly, sediment fluxes reversed with tidal phase, showing predominantly landward transport during flood tide and seaward transport during ebb tide. These results highlight the influence of well-mixed conditions and strong tidal currents on sediment transport. During the presentation, the

influence of tidal currents on the spatiotemporal variability of sediment transport will be discussed in more detail.

Evans, Noah^{1*}, Sophia Mercurio¹, Nina Stark¹, Emily Eidam²

Investigation of Variability in Hydrodynamic Forcings, Sediment Composition, and Geotechnical Properties of an Ultra-Soft Tidal Mudflat in Cedar Key, Florida

¹University of Florida; ²Oregon State University; *noahevens@ufl.edu

The fundamental geomechanics of tidal mudflats and their role in mudflat evolution and characteristics are highly complex and still poorly understood. A multidisciplinary field experiment was conducted in Cedar Key, Florida to elucidate the relationship among hydrodynamic forcings, sediment properties, and geomechanics, amongst other project goals. Data collection included hydraulic sensor measurements, in situ geotechnical tests, and lab tests performed on collected sediment cores. Sediment penetration resistance was measured using a portable free fall penetrometer (PFFP) and a dynamic cone penetration test (DCP). Two excess pore pressure dissipation tests were performed to explore in situ consolidation characteristics. Measurements obtained using acoustic Doppler current profilers (ADCP), optical backscatter sensors (OBS), conductivity, temperature, depth (CTD) sensors, tilt current meters (TCM), pressure sensors, and wave gauges were employed to quantify the bed stress, suspended sediment concentration, and water levels as primary comparison metrics with secondary consideration of salinity and temperature.

The mudflat was generally bordered by vegetation on each side and residential and touristic buildings on one side. A main channel was present along the southern edge that fed a tributary channel crossing the extent of the mudflat from south to north. The mudflat measures 250 meters from main channel to northern enclosed edge and 175 meters at its widest point. Preliminary data from deployed sensors suggest inundation periods vary across the mudflat from 95% inundated with a maximum water depth of 1.3 meters near the main channel to 75% inundated with a maximum depth of 0.9 meters. There was an observed decrease in salinity from 30 PSU adjacent to the major channel to around 20 PSU at the distant end of the mudflat. The general range of near-bed velocity from 0.3 to 0.7 meters per second was observed moving onto the mudflat.

Sediments comprise ~80% silt and 20% clay with minimal sand (0.1 %) in the top 15 cm with little down-core variability. Through the top 15 cm of soil, there was a minor decrease in moisture content with depth from approximately 85% to 75%. This work provides a uniquely integrated hydro-geo-environmental dataset to better understand the links between hydrodynamic forcings, sediment composition, and mechanical behavior on ultra-soft tidal mudflats with the goal to unravel fundamental relationships between hydrodynamics and geomechanics on tidal mudflats.

PhD Student

Figueroa, Steven^{1*}, Jarrell Smith¹

Comparison of Flocs in a Marsh Creek and Marsh Vegetation

¹US Army Engineer Research and Development Center, Coastal Hydraulics Laboratory, Coastal and Hydraulics Laboratory, 3909 Halls Ferry Rd., Vicksburg, MS, 39180; *stevenmiguelfigueroa@gmail.com

Coastal salt marshes provide critical ecosystem services, including wave attenuation, storm surge buffering, nutrient and carbon sequestration, and habitat for recreationally and commercially significant species. Cohesive sediment dynamics — particularly flocculation behavior — govern marsh resilience to sea level rise. Marsh creeks facilitate sediment exchange, while vegetated platforms attenuate flow and promote floc settling and vertical accretion. Characterizing how floc properties evolve across these environments is essential for predicting the trajectory of both natural and restored marshes, yet high-quality multi-tidal observations remain scarce due to logistical constraints.

Field observations were conducted at Eden Creek, an anthropogenically restored salt marsh on the eastern shore of South Bay, San Francisco Bay. South Bay lost approximately 85% of its wetlands to salt pond conversion after 1856. Eden Creek and adjacent ponds were restored in 2007 and have since accreted and supported marsh colonization. Data were collected over 12 days (July 23 – August 4, 2024) at a creek site and adjacent vegetated platform 3.5 km from the marsh mouth, using a novel self-propelled instrumented watercraft with a 5 cm draft, enabling rapid, minimally invasive deployment across the marsh surface at high tide.

Water level, mean currents, and turbulent velocities were measured by LevelLoggers and ADVs at 0.30 m (creek) and 0.10 m (vegetation) above the bed. Water samples drawn from intakes co-located with each ADV were analyzed every 30 minutes for floc size and settling velocity (LISST-200X and PICS camera), while ISCO samplers collected concurrent water samples for suspended sediment concentration and organic matter content. Valid observations were restricted to high-tide slack periods when the marsh surface was inundated.

Results reveal pronounced differences between the creek and vegetated platform in current velocity, suspended sediment concentration, floc size, and settling velocity. This talk presents these contrasts across a spring-neap tidal cycle, discusses their implications for marsh sediment dynamics, and highlights the capabilities of the mobile observation platform.

Ganju, Neil^{1*}, Rober Bales¹, Steven Suttles¹, Olivia De Meo¹, Eric Marsjanik¹, Wenxiu Teng², Jennifer Miselis¹; Joseph Smith³

Salt Marsh Establishment Controlled by Sediment Availability, Landscape Position, and Anthropogenic History

¹US Geological Survey; ²UMass-Amherst; ³US Fish and Wildlife Service; *nganju@usgs.gov

Anthropogenic actions have directly and indirectly modulated salt marsh extent globally. For example, direct actions such as draining and filling of marshes for agricultural production were common before the early 20th century, while residential development on barrier islands has indirectly reduced the capacity of back-barrier marshes to evolve in response to coastal processes. Similarly, restoration efforts span a spectrum between direct actions such as hydrologic reconnection and beneficial reuse of sediment to indirect actions such as shoreline protection and facilitation of upland migration. With a combination of remote sensing and synoptic in-situ observations, we demonstrate that the vegetative establishment of two disparate salt marsh complexes are strongly linked to their access to external fine sediment supply, position in the coastal landscape, and anthropogenic history. A marsh complex fringing Delaware Bay, in a former agricultural reclamation area, was directly modified through re-introduction of tidal forcing; vegetative establishment occurred rapidly (3% y⁻¹ increase in vegetative cover) due to a high flood-ebb suspended sediment differential (+32 mg l⁻¹), indicating sediment import. The other marsh complex, behind a sand spit fronting the Atlantic Ocean, vegetated indirectly in response to updrift beach nourishment which provided a sheltered environment for expansion. The lower suspended sediment differential (+1.3 mg l⁻¹) led to a slower vegetation establishment rate (1.7% y⁻¹). The directly modified and restored complex responded more rapidly than the indirectly modified and restored complex due to sediment availability. Direct restoration may be more rapid than indirect methods, and reversing anthropogenic impacts is possible on relatively short timescales, if sufficient external sediment supply exists. Siting of restoration projects should therefore leverage external forcing to accelerate recovery and enhance resilience. In light of ongoing coastal transgression, these examples also demonstrate a potential difference in return-on-restoration-investment between back-barrier marshes undergoing coastal squeeze and estuarine fringing marshes that are naturally transgressing across the coastal landscape.

Hu, Kelin^{1*}, Ehab Meselhe¹

Development of a River-Coast Integrated Sediment Transport Model for the Mississippi River Delta

¹Tulane University; *khu1@tulane.edu

Coastal Louisiana, including the Mississippi River Delta (MRD), has been experiencing multiple challenges since the last century, such as wetland loss, subsidence and sea level rise (SLR), riverine sediment load decline, and saltwater intrusion. Sediment transport in the MRD is extremely complicated due to the combined impacts from both riverine inputs and offshore hydrodynamics. A river-coast integrated sediment transport model has been developed based on the Delft3D-FM model suite from Deltares. The model domain covers the Mississippi River from Tarbert Landing to the MRD, the Atchafalaya River from Simmesport to the coast, and the coastal area.

The unstructured mesh resolution ranges from 100 m in the MRD to 15.7 km offshore. Three fractions of sediment are adopted in the model, that is, sand with median grain size (D50) of 120 microns, silt, and clay. Rating curves based on historical sediment measurements are applied to determine suspended sediment concentrations (SSC) at both riverine input locations, Tarbert Landing for the Mississippi River and Simmesport for the Atchafalaya River. Taken Water Year 2025 (Oct. 2024 – Sep. 2025) as an example, the model is carefully calibrated using observations of river discharge, river stage / water level, SSC for sand and mud (the sum of silt and clay in this study), suspended sediment load, and SSC distribution derived from satellite images. After model calibration, a series of scenario runs such as different flow split ratios at Old River Control Complex and different SLRs are carried out to investigate their impacts on sediment transport in the MRD. The results will be presented at the conference. The developed sediment transport model can further be applied to study long-term (e.g., decadal) morphological changes of the MRD. This study is part of the Mississippi River Delta Transition Initiative (MissDelta) project funded by the Gulf Research Program of the National Academies of Sciences, Engineering, and Medicine.

Kim, Su In^{1*}, Sun Min Choi², Seong Woon Jeong¹, Yerin Hwang¹, Pyeong Joong Kim³, Yong Hoon Kim⁴, Ho Kyung Ha¹

Typhoon-Induced Disruption of Stratification and Enhanced Sediment Transport in a Meso-Tidal Bay

¹Department of Ocean Sciences, Inha University, Incheon, Republic of Korea; ²Korea Institute of Ocean Science and Technology, Geoje, Republic of Korea; ³Blue Headquarters, Underwater Survey Technology 21, Incheon, Republic of Korea; ⁴Department of Earth and Space Sciences, West Chester University of Pennsylvania, West Chester, PA, USA

Typhoons can rapidly modify stratification and local current patterns in coastal and estuarine systems. However, the impact of typhoons on sediment transport mechanisms at event time scales remains poorly understood. An acoustic Doppler current profiler was deployed to investigate impacts of Typhoon Hinnamnor (September 5–7, 2022) on sediment transport in Yeosu Bay, Korea. Yeosu Bay, located on the southern coast of Korea, is a semi-enclosed embayment experiencing significant anthropogenic pressures, including dredging operation, land reclamation, and increased shipping traffic. This area is characterized by the combined effects of tidal forcing and freshwater discharge from the Seomjin River, leading to complex estuarine circulation patterns and stratification structure. Prior to the typhoon, freshwater discharge from the Seomjin River maintained strong stratification, which supported a two-layer circulation. The typhoon disrupted the semi-diurnal tidal regime and induced seaward flow throughout the water column. Wave-induced bed shear stress increased during peak wind period, but suspended sediment concentration remained elevated even after wave forcing decreased. This persistence coincided with strengthened current-induced bed shear stress, indicating that currents, rather than waves, sustained sediment

resuspension during the post-typhoon period. The typhoon effectively broke down stratification, reducing the temperature difference between surface and bottom (ΔT) to $< 0.2^{\circ}\text{C}$ and phase differences between surface and bottom tidal ellipses ($\Delta\theta$) to $< 18^{\circ}$. The resulting barotropic flow conditions weakened tidal straining while enhancing vertical mixing. Among stratification proxies, $\Delta\theta$ exhibited a strong correlation with ΔT ($r^2 = 0.72$), highlighting its potential as a practical proxy for stratification in topographically complex estuaries and coastal bays. Following the breakdown of stratification, enhanced vertical mixing and increased sediment availability promoted contribution of tidal pumping to total sediment fluxes from 29 to 54%. Landward sediment flux increased substantially despite bed shear stresses comparable to the pre-typhoon period. These findings demonstrate that typhoon-induced breakdown of stratification and sediment supply can fundamentally alter sediment transport mechanisms, highlighting how extreme weather events modulate sediment dynamics in a meso-tidal bay. Such knowledge is essential for coastal management and assessing estuarine ecosystems affected by typhoons.

PhD Student

Lee, Guan-hong^{1*}, Jongwi Chang², Raheem Abdul-Kareem¹, Courtney K. Harris²
Flocculation-Influenced Resuspension of Cohesive Sediments in a Sand-Dominated Mining Pit in Gyeonggi Bay

¹Department of Oceanography, Inha University, Incheon, 22212, Republic of Korea; ²Virginia Institute of Marine Science, William & Mary, Gloucester Point, VA, USA; *ghlee@inha.ac.kr

Flocs can form in virtually any environment. This study demonstrates that flocculation plays a role in the resuspension of mud within a sand mining pit where sand accounts for more than 90% of the sediment. In Gyeonggi Bay, approximately 15 million tons of marine sand were extracted between 2018 and 2023, creating numerous mining pits. We measured flow, suspended sediment concentration, particle size and bed level changes at the bottom of a representative pit (approximately 1 km long, 0.75 km wide, and 25 m deep) during January–February 2023.

Nearbed LISST measurements show that particle size increased to approximately 150 μm during slack water at both high and low tides, accompanied by an increase in total volume concentration. These observations suggest aggregation under low-shear conditions, with subsequent resuspension of flocs during tidal acceleration. To better understand the processes underlying these observations, a sediment transport model based on the ROMS was used to simulate the resuspension of sediment with representative grain sizes of 13, 45, 90, and 586 μm , representing clay, silt, fine sand, and coarse sand, respectively. Though this ROMS model neglected aggregation and disaggregation, the simulated particle size and suspended sediment concentration reproduced the observed trends: sand resuspension was primarily driven by bed shear stress, whereas clay exhibited phase-lagged transport linked to tidal

currents and vertical mixing. However, the ROMS model did not represent the particle sizes observed in the LISST data.

A one-dimensional two-class population balance equation (1D TCPBE) was applied to investigate floc resuspension. The 1D vertical TCPBE model shows that the increases in particle diameter and concentration observed during slack water in the LISST data are associated with floc formation. This study demonstrates that the suspension dynamics of cohesive sediments are strongly influenced by flocculation, even in environments where sand accounts for more than 90% of the sediment.

Lin, Lihwa^{1*}, Tzenge-Huey Shih², Timothy J. Connell², Anhthu Nguyen²

Atchafalaya River Outlet Hydrodynamic and Sediment Transport Modeling

*¹US Army Corps of Engineers Research and Development Center; ²US Army Corps of Engineers New Orleans District; *lihwa.lin@usace.army.mil*

The US Army Corps of Engineers (USACE) Research and Development Center and New Orleans District Office are presently teamed to investigate the substantial channel shoaling rate at the Atchafalaya River Outlet, Louisiana. The federal navigation channel in the Lower Atchafalaya River is a 20-foot deep by 400-foot wide channel extending from near Morgan City, Louisiana, through the Atchafalaya Bay to the Gulf of America. This waterway, intersects the important Gulf Intracoastal Waterway south of Morgan City and connects Crewboat Cut near Horseshoe Bend to Bayou Black, has served as a major commercial route that requires more often maintenance dredging. Between FY2020 and FY2025, 12 dredging contracts were awarded by the USACE to maintain the authorized channel dimensions within the Lower Atchafalaya River and navigation canals from Crewboat Cut to Bayou Black.

A USACE Coastal Modeling System (CMS) was developed to simulate the lower Atchafalaya River hydrodynamics and associated breaking waves outside the river mouth using NOAA, NDBC, and USGS hydrographic/oceanographic data. The model domain covers the lower Atchafalaya River Basin, Atchafalaya Bay and adjacent coastal waters. The CMS has a mixed sediment transport module to calculate both bed load and suspended load for a wide range of sediment characteristics including sand, muddy sand, and fluid mud. The model sediment transport driven by river discharge and tidal currents interacting with wave action outside the river mouth was calibrated based on recent dredging records and available field sediment data collection. The sediment transport modeling was conducted for a 1-year simulation of 2025 representing the normal environmental forcing condition without any major tropical event.

The modeling system provides opportunities to improve dredging efficiency by investigating whether certain channel reaches exhibit a greater tendency for shoaling, involving heavy silty sand and mud in the lower Atchafalaya River, and therefore requires more frequent dredging cycle, or whether dredging intensity can be optimized during specific periods when dredged material becomes highly concentrated, and

whether potential foreshore protection features or jetty alternatives for the bar channel leading into the bay channel could reduce shoaling impacts. The preliminary model result indicates the excessive sediment shoaling rate observed in the lower Atchafalaya River Outlet is likely caused by the local channel tends to reach the appealing natural semi-equilibrium depth which is generally smaller than the authorized depth under the mixed fine sediment condition. To reduce the channel shoaling rate, the ongoing modeling is looking at potential structural solutions of foreshore protection features along the inland channel and jetty construction along bar channel minimizing sediment source enter and accumulate in the channel. More model results will be presented at the conference.

Mariotti, Guilio^{1*}, M.A. Allison², E.A. Meselhe², M. Hiatt¹

*Upstream Supply, Backwater Hydrodynamics, and Transient Bed Storage Control
Delivery of Mississippi River Sediment to its Delta*

¹Louisiana State University; ²Tulane University; *gmariotti@lsu.edu

Riverine sediment is crucial for the accretion of deltaic regions. In the Mississippi River Delta, riverine sediment delivery is controlled both by backwater hydrodynamics (local effect) and by upstream supply (non-local effect). Here we elucidate these two controls by combining field data and remote sensing, spanning the lower 1500 km of the river and its plume. Field data within the river identify a hysteresis for both suspended sand and mud: for the same discharge, their concentration later in the flood season is ~50% lower than during the early flood season. Sand concentration increases monotonically with discharge throughout the year, whereas mud concentration increases monotonically with discharge during the early flood season, but it decreases or plateaus with discharge during the late flood season. Remote sensing from 2001 to 2025 reveals that total (sand plus mud) suspended sediment (TSS) is relatively uniform in the lower 500 to 1500 km of the river, suggesting that the hysteresis is not caused by release of in-channel storage, but by supply from upstream of river km 1000 to 1500. In the lower 500 km, the hysteresis is compounded with the backwater hydrodynamics. During low discharge (decelerating flow) TSS decreases downstream, indicating temporary in-channel storage and reduced delivery to the delta. During moderate discharges, even when the flow decelerates downstream, TSS could increase due to resuspension of previously stored sediment (mostly mud). During very high discharge (accelerating flow), TSS increases downstream, indicating local resuspension. Even though backwater hydrodynamics and temporary bed storage modulate the timing of sediment delivery, they are generally overshadowed by the upstream sediment supply (hysteresis), such that high discharges late in the flood season have a TSS that is about half that of low discharge early in the season. These dynamics control the timing of sediment delivery to the delta and are directly affecting TSS in the river plume.

Moriarty, Julia^{1*}, Brianna Undzis¹

The Role of Local Resuspension on Oxygen Exposure Time

¹University of Colorado Boulder; *Julia.Moriarty@colorado.edu

The extent to which seabed organic matter is remineralized versus buried impacts marine carbon budgets, water column chemistry, and interpretation of the geologic record. Exposure to oxygen has long been shown to enhance remineralization. In coastal regions, resuspension is thought to enhance the amount of time particles are exposed to oxygen, i.e. oxygen exposure time (OET), but this remains difficult to quantify. This study therefore proposes a method for quantifying OET that accounts for resuspension. Using timeseries of seabed elevation, the frequency of resuspension for different layers in the seabed was calculated and used to estimate the amount of time that seabed organic matter was resuspended from anoxic portions of the seabed into the water column. This quantity, i.e., the resuspension-induced OET, was added to the time organic matter was exposed to oxygen during burial. Results showed that resuspension accounted for half of OET in the sub-aqueous Rhône delta, although this was likely a conservative estimate based on the assumptions used. Analysis for both the Rhône delta and idealized sites demonstrated that the fraction of OET due to resuspension increased with thinner oxygen penetration depths in the seabed, as well as more frequent and deeper resuspension. Both the resuspension-induced and total OET also decreased with sedimentation rate. Overall, these results implied that resuspension can contribute substantially to OET in coastal environments such as sub-aqueous deltas. Additionally, this method for calculating OET can contribute to ongoing research efforts to better quantify variability in organic matter remineralization.

Palinkas, Cindy^{1*}, Lorie Staver¹

Sediment Dynamics in the Created Marshes of Living Shorelines

¹University of Maryland Center for Environmental Science, Horn Point Laboratory; cpalinkas@umces.edu

Shorelines in many estuaries and coastal embayments face increased erosion from such threats as accelerated relative sea-level rise, intensifying storm activity, and rapid urbanization. In response, efforts to stabilize coastlines are increasing and focus on nature-based solutions (NbS; also called nature and natural-based features; NNBF) rather than traditional shoreline hardening. Among these, living shorelines (defined here as created tidal marshes protected by low-lying rock sills) have emerged as a primary strategy for shoreline stabilization. However, implementation has outpaced the long-term monitoring and research needed to understand their ecological evolution. Critical knowledge gaps remain regarding the timeline and mechanisms by which these systems transition from initial bare sand with sparse plantings into ecosystems with fine, organic-rich muddy sediments and dense vegetation that are similar to natural marshes. To address these uncertainties, this study utilizes a unique, comprehensive dataset collected from living shorelines of various ages across the mesohaline region of the Chesapeake Bay. By comparing projects spanning a wide temporal gradient, we can

evaluate the primary drivers of sediment and vegetation dynamics, as well as sediment-vegetation feedbacks. Our findings reveal a distinct decoupling in the development timelines of the physical and biological components. The vegetation community establishes rapidly, achieving dense, mature coverage within the first few years after construction. Conversely, sediments take 8-10 years to transition from sand to an organic-rich muddy composition. Once both the sediments and vegetation reach a dynamic equilibrium, environmental factors become the primary drivers of ecological differences among sites. These data are used to develop predictive empirical models to quantify and forecast outcomes of living shoreline installations. Ultimately, this study defines expected trajectories for sediment and vegetation development and identifies site-specific characteristics that may impact these trajectories to inform adaptive management plans, permit requirements, and other needs of coastal engineers, managers, and policymakers.

Pedocchi, Francisco^{1*}, Rodrigo L. Mosquera¹

Sediment Entrainment into Suspension from Granular and Cohesive Beds

¹Instituto de Mecánica de los Fluidos e Ingeniería Ambiental, Universidad de la República, Uruguay;

*kiko@fing.edu.uy

The entrainment of sediments into suspension from both granular and cohesive beds is revisited using a unified momentum-based theoretical framework. For granular sediments, the analysis of near-bed particle dynamics shows that the dimensionless entrainment rate is proportional to the excess bed shear stress, consistent with the classical form of the Smith and McLean (1977) relation. However, the proportionality coefficient γ , previously treated as a constant, is shown to be a function of the particle Reynolds number, Rep . This dependence arises naturally from the theoretical derivation, which links γ to the critical Shields number and the dimensionless settling velocity, both of which vary with particle size. The proposed relation is calibrated against a compiled dataset of 82 laboratory measurements of near-bed sediment concentration, covering very fine to fine sand under conditions free of significant bedform influence. Despite relying on a single calibration constant, the new relation performs exceptionally well, placing fewer data points outside a one-order-of-magnitude band than all alternative formulations tested, including the widely used García and Parker (1991) and de Leeuw et al. (2020) relations.

The same momentum-balance framework is subsequently extended to cohesive sediment beds. In this case, the eroded particles are flocs whose size, density, and settling velocity depend on the internal structure of the bed. Incorporating a fractal description of floc properties, a new relation for the erosion rate coefficient M in Kandiah's (1974) equation is derived, showing that M is proportional to the critical shear stress τ_0 and depends on bed concentration and a fractal exponent B that characterizes the aggregation state of the bed. Calibration against the dataset compiled by Lee et al. (1994), comprising 110 erosion experiments, reveals a systematic difference between

artificially prepared and undisturbed natural beds, with natural beds exhibiting higher fractal exponents and consequently larger erosion rate coefficients for the same concentration and critical shear stress, reflecting a more open, less consolidated pore structure. This distinction is attributed to differences in the microscale bonding structure of the bed, which controls floc size at the moment of erosion.

The parallel derivation of both relations from a common physical basis provides compelling evidence that granular entrainment and cohesive bed erosion are governed by the same near-bed mechanical processes: particle displacement against resisting forces and acceleration from rest to the scale of the settling velocity. This unification has a relevant practical implication: entrainment relations for granular sediments calibrated under equilibrium conditions may be applied to nonequilibrium transport, and equilibrium between erosion and deposition should in principle be achievable over cohesive beds as well.

Phung, Thi Hong Na^{1*}, Sungyoon Jung¹

Spatial Distribution of Heavy Metals and Microplastics in Surface Sediment from Cedar Key Tidal Flats, Florida: Correlation between Physico-Chemical Properties

¹Department of Environmental Engineering Sciences, University of Florida, USA;

*thihongn.phung@ufl.edu

Tidal flats are transitional zones between terrestrial and marine environments and an important coastal wetland for both ecosystems and human communities. However, increasing human activities and dynamic land-sea interactions enhance the role of tidal flats as major sinks for diverse anthropogenic pollutants, including microplastics and heavy metals. Microplastics (particles < 5 mm) are emerging global pollutants in aquatic and marine environments due to their persistence, accumulation potential, and long-term ecological risks. Heavy metals are among the most hazardous environmental contaminants because of their toxicity, bioavailability, persistence, and tendency to bioaccumulate in the food chain. When released into tidal flats, both microplastics and heavy metals can be trapped by sediments, posing serious threats to both natural and artificial ecological systems. Despite their environmental importance, the spatial distribution of these contaminants in the Cedar Key tidal flats, Florida, remains limited and poorly understood. To assess microplastics and heavy metals distribution within tidal flats, we studied eight sites in the North Flat and eight sites in the South Flat of Cedar Key with varying sediment type, geomorphology, and anthropogenic influences. In this study, the contamination levels and origin of eleven elements (V, Cr, Co, Ni, Cu, Zn, As, Cd, Pb, Ca, and Mg) were investigated. In parallel, microplastics were characterized in terms of abundance, size, morphology, and color. Furthermore, it analyses in more detail the relationship between physical and chemical in tidal sediments. Data from this study provides an initial framework for understanding the spatial diversity of heavy metals and microplastics in Cedar Key tidal flats. It is expected that the distribution of these contaminants will be influenced by differences in sources of

inputs, sediment physical properties, and geomorphology. This work will contribute to improving the understanding of pollutant-sediment interactions in tidal flat environments and will facilitate future studies investigating the linkages between physico-chemical properties and contaminant dynamics in coastal systems.

PhD Student

Priestas, Anthony^{1*}, Stephen Gonski¹

Predicting Mud Aggregate Durability in Dredge Pipelines: A Synthesis of Laboratory Attrition Data Toward a Planning-Level Tool

¹USACE-ERDC; * anthony.m.priestas@usace.army.mil

The survival of cohesive sediment ("mud") aggregates during hydraulic transport governs the beneficial use potential of fine-grained dredged material. At the discharge end of dredge pipelines, aggregates may degrade and arrive as dispersed fines or persist as aggregates. Predicting the attrition rate with pipeline distance has consequences to both the beneficial use case of that material and the pump efficiency of dredging operations.

This study synthesized laboratory attrition data from three independent experimental programs spanning a wide range of sediment types and geotechnical conditions to identify controlling parameters and assess the feasibility of developing a unified empirical model.

Results showed that Liquidity index (LI) emerged as the dominant predictor of attrition rate, explaining approximately 60% of combined variance, and modeled as a single-term exponential function. However, site-specific polynomial regressions showed substantially higher coefficients of determination ($R^2 = 0.79\text{--}0.98$), indicating that other sediment characteristics likely modify the primary LI dependence in ways that are not fully resolved from the general trend. Nonetheless, the empirical model estimates transport distances to 95% relative mass loss ranging from approximately 3,000 ft for firm sediments ($LI \approx 0$) to under 1,000 ft for much weaker materials ($LI > 1.2$).

These findings provide a modest, first-order method to predict aggregate attrition, though field validation and additional laboratory investigations are priorities. With further development, this approach could offer planners a straightforward tool for estimating the likelihood of aggregate persistence to support decisions about placement site selection, beneficial use feasibility, and operational planning.

Schuh, Elin^{1*}, Holger Weilbeer¹, Sebastian Fuerst¹

Accumulation of Fine Sediments in the Elbe Estuary

¹Federal Waterways Engineering and Research Institute (BAW), Germany; *elin.schuh@baw.de

During the period 2013–2018, several striking hydrological and morphological changes took place in the Elbe Estuary in Germany, an important coastal navigation route into the North Sea. Significant increases of maintenance dredging quantities concerning fine grained sediments occurred in the Port of Hamburg, but also in fairway

sections further downstream as well as in the ancillary areas and ports along the tidal Elbe. Comparably, sedimentation rates have also increased. In some sections, a strong fining of sediments in combination with a smoothing of the river bed could be observed. Simultaneously, changes in water levels and currents were noticeable (Weilbeer et al., 2021). The amplification of the tidal range was unusually large especially in the inner estuary, where measuring stations registered an increase in flow velocities and higher levels of turbidity.

An increase of the turbidity could be observed at all measuring stations in the Elbe Estuary, but with a time shift over three months. The measuring stations further upstream registered these shifts in the turbidity level later. A sequence of exceptional hydrological and meteorological events may be a possible reason for this upstream transport of fine sediments. It starts with a very high fresh water inflow in summer 2013 at the tidal barrier, which flushes out the fine sediments to the mouth. Since then no more flushing event happened. Then two storm events occur, on 28.10.2013 and on 5./6.12.2013, which remobilized a huge amount of sediments in the Outer Elbe. These sediments reached the fairway and are being transported upstream due to tidal pumping. The turbidity level remains high, because the sediment is trapped in the upper estuary and not completely removed by an adapted sediment management.

The measured observations are now modelled by using the 3D-model of the Elbe Estuary. In order to understand the hydromorphological changes within the Elbe estuary hindcast simulations are applied. Several modelling approaches and parametrizations like consolidation, porosity, critical shear stress, erosion flux and settling velocity, which determine the suspended sediment transport were adapted and fitted based on field and experimental data in order to simulate the observed upstream transport in the fairway. Real dredging data were considered, too. The importance of specific modelling approaches and their interaction is discussed.

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PhD Student

Shin, Jae Hyeok^{1*}, Sun Min Choi², Su In Kim¹, Kyungsik Choi³; Ho Kyung Ha¹
The Variation in Sediment Transport Induced by Storm in a Macro-Tidal Flat, Garolim Bay: Preliminary Results

¹Department of Ocean Sciences, Inha University, Incheon 22212, Republic of Korea; ²Library of Marine Samples, Korea Institute of Ocean Science and Technology, Geoje 53201, Republic of Korea; ³School of Earth and Environment Sciences & Research Institute of Oceanography, Seoul National University, Seoul 08826, Republic of Korea; *ukia3612@gmail.com

Intertidal flats are land-ocean interaction areas where sediment transport is closely associated with sediment exchange in tidal channels and responds to variations in tidal and wind conditions. Garolim Bay, located on the west coast of Korea, is a

semi-enclosed bay characterized by a macro-tidal regime (mean tidal range: ~ 7 m). To investigate the impact of a storm on sediment transport in Garolim Bay, two acoustic Doppler current profilers (ADCPs) were moored in the main channel (MC) and subtidal channel (SC) from September 17 to 26, 2023. During fair-weather periods, the maximum current-induced bed shear stress (τ_c) reached 0.48 and 0.40 Pa, while the maximum suspended sediment concentration (SSC) reached 145 and 130 mg l⁻¹ at MC and SC, respectively. During the storm period (wind velocity: > 9 m s⁻¹; rainfall: > 5 mm h⁻¹), although τ_c showed little variation, the maximum SSC increased up to 276 and 180 mg l⁻¹ at MC and SC, respectively, with higher SSC observed in the surface layer than in the bottom layer. Furthermore, the SSC response at MC was significantly correlated with wave-induced bed shear stress (τ_w) during the storm period ($R = 0.64$; $p < 0.02$), whereas no significant relationship with τ_w was observed during fair-weather periods. This suggests that the increase in SSC during the storm period was primarily attributed to sediment advection rather than local resuspension. After the storm period, progressive vector plots of sediment flux revealed that the direction of sediment flux at MC shifted from southeast to northeast, whereas at SC, it shifted from northeast to northwest. These results indicate that the direction of sediment transport changed during this period, likely due to strong winds and heavy rainfall that altered sediment exchange within tidal channels. This study highlights the role of storm events in modifying sediment transport patterns in tidal channels of a macro-tidal flat.

PhD Student

Smith, S. Jarrell^{1*}, Gregg Snedden², Steven Figueroa¹, Michael Ramirez¹

Physical and Biological Controls on Seasonal Sediment Exchange in Salt Marsh Tidal Creeks

¹US Army Corps of Engineers; ²US Geological Survey; *Jarrell.Smith@usace.army.mil

The United States Army Corps of Engineers (USACE) strives to expand the Beneficial Use of Dredged Material (BUDM), particularly for fine-grained sediments, to reduce dredging costs and to benefit coastal communities and ecosystems. Coastal salt marshes require increased inputs of mineral sediment to keep pace with current and projected rates of sea-level change. The mineral sediment needs of coastal marshes present a significant opportunity for the USACE to reduce dredged material transport distances and costs and to increase coastal marsh resilience. To better understand the capacity of tidal channels to deliver dredged sediment to salt marsh interiors, two year-long studies of sediment exchange through tidal creeks were conducted near Stone Harbor, New Jersey and Hayward, California. In both studies, seasonal variations in sediment delivery were observed, associated with physical and biological controls on the salt marsh and adjacent bays. At the New Jersey site, seasonally higher sea level and biological activity in the summer contributed to over 90% of the net sediment export from the creek during overbank tides—conditions that amount to only 30% of the

observed tidal cycles. At the San Francisco Bay site, seasonal sea breezes during March to October generate waves and higher sediment concentrations near the creek mouth that results in seasonal import of sediment to the creek and the salt marsh plain. These findings exemplify the importance of accounting for seasonality in sediment fluxes when assessing sediment budgets of salt marshes and illustrate how sediment budgets assessed with shorter duration datasets may exhibit seasonal bias. Additionally, these observations suggest that BUDM applications should factor seasonality in the sediment dynamics to increase sediment capture and retention by salt marshes.

Tarpley, Danielle^{1*}, S. Jarrell Smith¹, Kelsey Fall²

Characterizing Sediment Particle Dynamics Near the Head of Salt in the Mississippi River Under Varying Flow Conditions

¹USACE-ERDC; ²University of Delaware; *danielle.tarpley@usace.army.mil

Southwest Pass is the primary distributary and navigation channel of the Mississippi River delta, connecting the river to the Gulf of America (formally Gulf of Mexico) and supporting one of the busiest commercial shipping corridors in the United States. The region near the delta apex (called head of passes) is subject to rapid sediment accumulation that frequently necessitates emergency dredging operations, yet the hydrodynamic and sedimentological mechanisms driving this deposition are not well understood. This study investigates how varying river discharge conditions, and the position of the salt wedge influence the size, density, and settling behavior of cohesive sediment in the water column.

Measurements of particle size, settling velocity and density were obtained using a novel Particle Imaging Camera System (PICS). The system leverages image-based processing routines that simultaneously track fluid motion and particle trajectories, enabling in-situ measurements of particle size and settling velocity that are then used to estimate particle density. In-situ measurements of suspended sediment properties were collected surrounding the head of salt during four field campaigns representing contrasting hydrodynamic regimes. During low-flow periods in 2015 and 2016, the head of salt was positioned above the delta apex constraining the estuarine turbidity maximum (ETM) and flocculation dynamics upstream. During high-flow events in 2021 and 2025, the salt wedge was pushed further downstream below the delta apex. This zone of sediment-salinity interaction promoted the formation of large, less dense flocculated particles, while elevated hydrodynamic conditions suspended and transported dense bed aggregates to the lower reaches. Both particle types preferentially accumulate within the navigation channel, enhancing sedimentation rates downstream of the salt front. These findings have direct implications for dredging forecasting and sediment management strategies in the lower Mississippi River.

Tautenhahn, Paul^{1*}, Eckart Meiburg¹

Rheology of Partially Cohesive Suspensions

¹University of California, Santa Barbara; *ptautenhahn@ucsb.edu

The present work focuses on investigating the effect of cohesion on the rheology of particle laden suspensions using fully phase resolved direct numerical simulations of three-dimensional wall bounded shearing flow. The discrete element method (DEM) is used to simulate the particle-particle and particle-wall interactions, whilst the immersed boundary method (IBM) is used to treat the particle-fluid interaction by enforcing the no-slip boundary condition on the particle surfaces.

By varying the cohesive fraction (ratio of cohesive particle volume to total particle volume) of the simulated suspension we aim to gain a better understanding of the effects of cohesion on suspension rheology and the physical mechanisms which characterize the observed rheological behavior. Using fully resolved simulations of the suspensions enables investigation of the bulk effects of cohesion as well as particle scale phenomena which give rise to the observed rheological behavior. From the particle scale information we can also gain insight into mesoscale behavior of collections of particles such as the role of aggregates and cohesive force chains, allowing us to connect particle and mesoscale behavior to bulk rheology. Additionally, the particle resolved approach enables assessment of the stress balance for each particle and for each phase as a whole, making these simulations an ideal tool for characterizing the effect of cohesion on the mechanics of suspensions. Using this approach also allows us to separate particle size effects from the effect of cohesion, which is a major challenge in experimental studies of partially cohesive suspensions.

We will present results spanning a range of volume and cohesive fractions from dilute to dense suspensions at cohesion fractions between 0 and 1, focusing on how cohesion modifies the suspension rheology for the various regimes observed across the parameter space. We will also discuss the effect of cohesion on the yield stress and yielding and unyielding behavior of suspensions. By examining the stress balance of the particle phase and mixture we observe that introducing cohesion increases the total stress of the suspension in two ways: the additional cohesive stress contributes a relatively small amount whilst the formation of cohesive aggregates, which are structures larger than the primary particles, increases the hydrodynamic and collisional stress on the particle phase.

PhD Student

Toorman, Erik^{1*}

A Semi-Analytical 1DV Model for Boundary Layer Sediment Transport

¹Hydraulics & Geotechnics, Dept. of Civil Eng., KU Leuven; *erik.toorman@kuleuven.be

Analysis of experimental and DNS data for open and closed boundary layer and channel flows over a wide range of Reynolds numbers has allowed to define alternative (semi-)analytical closures for eddy viscosity (ν_t), turbulent kinetic energy (k) and its

dissipation rate (ϵ) which intrinsically take into account both the inner and outer scaling effects, from the laminar to the fully-developed turbulent layer, and thus also the Reynolds number dependencies. Substituted into the extended non-dimensionalized stress balance, which comprises extra terms for bottom roughness and sediment transport, this equation allows to calculate the velocity profile by numerical integration over the vertical. Substituted into the vertical sediment flux balance, it allows to compute the vertical SPM concentration profile by numerical integration. The model requires a few empirical parameters to be calibrated. Unfortunately, very few data sets prove to be suitable for this purpose as very few measurements have been carried out in sediment-laden inner boundary layers. Results from a 1DV model will be presented for both non-cohesive and cohesive sediment transport, each differing by their constitutive equation for the suspension rheology. Perspectives for future applications and implementation in numerical morphodynamic models will be discussed.

Van Maren, Bas^{1*}

Erosion and Consolidation of Sand-Mud Mixtures

¹Deltares; *bas.vanmaren@deltares.nl

The erodibility of sand-mud mixtures is highly variable, depending on the relative amount of sand, the density of the mixture, the type of clay-sized minerals, stress history and biologic effects. The density of the mixture is determined by consolidation rates, in turn also controlled by the sand content and clay properties. A large amount of experimental work has done on determining the initiation of motion of such mixtures. Most of this work concentrated on undisturbed field beds, introducing a large range in controlling variables which are also poorly documented, such as the exact bed density. In this contribution we determine initiation of motion of sand-mud beds as a function of sand content and density, working with remoulded samples only and focussing on natural clay-influenced muds mainly composed of illite. Though a range of systematic bed erosion tests combined with existing literature, this focus on remoulded, natural muds provides a surprisingly coherent pattern of critical bed shear stress as a function of density and sand content which can be reproduced with a very simple expression. Subsequently applying this expression to experiments executed with non-illite mixtures reveals that the erosion is structurally higher when using bentonite but lower when using kaolinite, even lower for carbonate sediments and lowest for quartz-dominated mixtures. The density of the mixtures is then further investigated with a newly developed sand-mud consolidation model. Following up on an earlier simplified consolidation model for which we develop a sand content dependant permeability function, we quantify the density evolution of mixtures as a function of sand content. Combining this with our new erosion formulation, we can quantify the evolution of bed strength over time as a function of sand content and thickness of the deposit. This combined

erosion-consolidation model predicts the highest bed shear stress of mixtures to occur at intermediate sand-mud content, in agreement with earlier observational evidence.

Van Prooijen, Bram^{1*}, Anna Enge¹

Event-Driven Erosion in the Norwegian Trench

¹Delft University of Technology; *b.c.vanprooijen@tudelft.nl

The Norwegian Trench is with depths until 500m the deepest part of the North Sea. It is considered an important sink for sediment, carbon and nutrients. Previous studies suggest the accumulation of sediments with approximately 1 mm/year. Whether this accumulation also implies a storage of carbon and nutrients depends on the mobility of the bed. We therefore explore whether the system is purely depositional, or whether erosion events could stir up the bed, potentially releasing carbon and nutrients.

In order to determine where, when and how much erosion takes place, we (i) deployed a mooring line with velocimeters to determine the hydrodynamic forcing near the bed and (ii) took sediment cores to test the erodibility with a Gust Erosion Microcosm System (GEMS). The mooring line was deployed in the Norwegian Trench at 60.37 °N, 4.29 °E, where the bed level was at a depth of 270m. The mooring line was equipped with a variety of instruments. Here we use the results from the ADV (Nortek Vector) at 5m above the bed, the downward looking ADCP (Nortek Signature1000) at 20m above the bed and the turbidity sensor (WetLabs FLNTU). The mooring line was deployed for the period between May 2023 and June 2025 and was serviced in May 2024.

The sediment samples show clear differences in sediment composition. The deeper parts in the Norwegian Trench are muddy, while the samples on the west side, closer to the shallower part of the North Sea, are sandier. This is directly reflected in the GEMS results, where hardly any erosion was measured for the sandy samples, while erosion is observed for the muddier samples. Although erosion was measured for lower shear stresses, it generally stopped after a few minutes, indicating supply limited (Type I) erosion. Only for higher shear stresses (from 0.5Pa on) a constant erosion rate was observed, indicating Type II erosion.

The flow velocities show tidal fluctuations with amplitudes up till 0.2m/s during spring tides. A clear seasonal pattern is observed with higher flow velocities in winter than in summer. These higher flow velocities are a consequence of the storms on the North Sea. The water level set up in the shallow part of the North Sea leads to return currents in the deeper Norwegian Trench. Flow velocities increase to 0.4m/s. These events resulted in a response of the turbidity sensor as well as in an increase of the SNR value of the ADV, indicating an increase in sediment concentration due to erosion of the bed.

We conclude that the Norwegian Trench is in general a system where erosion is limited and where sediment deposits, as the tidal flow velocities do not exceed the

thresholds for substantial erosion and as the turbidity levels are low. During storm events, the velocities can however exceed the threshold for Type II erosion, leading to erosion of the bed.

van Weerdenburg, Roy^{1,2*}, Bas van Maren^{1,2}, Thijs van Kessel², Ismail Myouri¹, Bram van Prooijen¹

Drying of Intertidal Mudflat Beds and Its Effect on Sediment Erodibility

¹Delft University of Technology, ²Deltares; *r.j.a.vanweerdenburg@tudelft.nl

The resuspension of fine sediment from intertidal mudflats plays an important role in sediment dynamics in coastal systems and estuaries, contributing to increased turbidity levels and channel siltation. Many earlier studies have therefore aimed to quantify the erodibility of mudflat sediments, and recent works have observed reduced intertidal mudflat erodibility after periods of aerial exposure. In this study, we aim to quantify the occurrence of drying of intertidal mudflat beds during such exposure periods and to unravel its effect on sediment erodibility and mudflat evolution.

During a recent measurement campaign in the Dutch Wadden Sea, we measured pore-water pressures to quantify drying of the sediment bed of an intertidal mudflat over a period of three months. In addition, spatial variation in erodibility was determined with a set of Gust Erosion Microchamber System (GEMS) experiments. Our measurements reveal that drying of the top layer of the sediment bed occurs as a result of evaporation rather than drainage via groundwater flows. The degree of drying increases with cumulative potential evaporation during aerial exposure, which may be prolonged by set-down of the water level. Drying does not occur during low-water periods at night or when potential evaporation is low (cloudy and/or cold weather). It occurs at elevated parts in the microtopography of a mudflat, and not in local depressions where shallow ponds of water remain during low water. Drying may induce stresses in the surface layer that are an order of magnitude larger than those induced by self-weight consolidation, leaving the mudflat bed in an over-consolidated state.

At both small (ridges and runnels) and larger spatial scales along the elevation profile, drying stabilizes the sediment bed in elevated areas, making it more resistant to erosion during subsequent flooding. As evaporation is the main (physical) mechanism driving reduced erodibility, these dynamics likely control the temporal (e.g., seasonal) variations in mudflat erodibility and, consequently, sediment dynamics. We therefore interpret and upscale our observations by setting up a combined self-weight and suction-induced consolidation model to (1) reproduce the field observations and link drying to erodibility, and (2) upscale the results from point measurements to the entire mudflat elevation profile.

PhD Student

Wang, Dayu^{1*}, Le Wang², Chenge An¹, Lei Zhang¹

Coupled Effects of Hydrodynamics and Algal Organic Matter on Sediment Flocculation in the Three Gorges Reservoir: From Laboratory Quantification to Field Evidence of Dual Sediment Sorting

¹China Institute of Water Resources and Hydropower Research; ²North China Electric Power University;

*dayu.wang@hotmail.com

The Three Gorges Reservoir (TGR), China's largest water conservancy project, has accumulated ~1.8 Gt of sediment since 2003. Two anomalous sedimentation phenomena challenge traditional hydrodynamics and reservoir management: (1) fine particles (<0.01 mm), predicted non-settling pre-impoundment, account for ~50% of total deposition; (2) dry-season (Nov-Apr) sediment discharge ratios (>40%) under high water levels and weak hydrodynamics exceed flood-season values (25-35%). While sediment flocculation is hypothesized as the core mechanism, coupled physical-biological controls remain poorly quantified.

Our previous laboratory study isolated physical controls on TGR flocculation using a bespoke Couette flow system mimicking reservoir low-turbulence conditions. Experiments used undisturbed dam-front sediments (organic matter removed) covering realistic shear rates ($G=4.7\sim227\text{ s}^{-1}$) and concentrations ($C=0.2\sim2.0\text{ kg/m}^3$). Key findings: (1) Floc size follows a unimodal Gaussian distribution with shear rate, peaking at 90 μm at $G=72.5\text{ s}^{-1}$; (2) A new empirical parameter $C^{0.44}/G^{0.47}$ outperforms conventional $C/G^{1/2}$ in characterizing floc size variability; (3) Floc settling velocity is ~5 $\times$ that of primary fine particles ($D\leq29\text{ }\mu\text{m}$), confirming flocculation enhances fine sediment deposition. These results established quantitative physical controls but neglected the critical role of biogenic organic matter in TGR waters.

Building on these findings, field observations were conducted in the TGR near-dam perennial backwater zone (~20°C). Two sections were sampled: Miaohe (15 km upstream, tributary-influenced) and dam front (deep trough/shallow shore sub-sites). A multi-proxy approach included phytoplankton quantification, mineral analysis, and ultrasonic particle size analysis to distinguish flocs from primary grains. Results show: (1) Miaohe has 4.1 $\times$ higher algal biomass, dominated by high-EPS *Euglena* and *Trachelomonas*; (2) Ultrasonic treatment reveals a floc preservation gradient: >25 μm particles decreased by 29.8% (Miaohe), 24.3% (dam deep trough), 10.1% (dam shallow shore) post-disaggregation, reflecting flocculation intensity and post-depositional disturbance; (3) Flocculation induces dual sediment sorting in particle size and mineral composition: fine particles are preferentially transported downstream; dam-front sediments have higher clay content (42% mica+chlorite vs. 31% Miaohe), while Miaohe is enriched in inert quartz (36%) and feldspar (17%), confirming preferential floc incorporation of clays.

This integrated study combines laboratory physical quantification with field biological evidence, advancing understanding of freshwater flocculation. It explains

TGR's anomalous sedimentation and informs reservoir management optimization. Future work will quantify temperature-organic matter coupling effects on seasonal flocculation.

Witt, Markus^{1*}, Justus Patzke¹, Edgar Nehlsen², Peter Fröhle¹

Erosion of Freshly Deposited Cohesive Sediments: Systematic Analysis Across Laboratory and Field Experiments in the Elbe Estuary

¹Hamburg University of Technology; ²Technical University of Applied Sciences Lübeck;

*markus.witt@tuhh.de

The quantification of the erodibility of cohesive sediments is fundamental for an advanced understanding of estuarine sediment transport processes and provides an essential basis for numerical modeling. Despite substantial research efforts over recent decades, important questions remain unanswered regarding the key relationships between the various factors controlling the erosion of cohesive sediments, as well as the appropriate representation of erosion thresholds and rates in mathematical models.

This study presents a comprehensive analysis of the erosion behavior of cohesive sediments in the Elbe estuary based on laboratory and field experiments, with a focus on freshly deposited, low-density sediment layers. A central component of the study is the application of the newly developed C-GEMS device, a closed-system modification of the established Gust Erosion Microcosm System. The C-GEMS enables the investigation of remolded or artificial sediment samples, extracted natural sediment cores, and in-situ conditions within a consistent methodological framework, thereby facilitating improved comparability between different experimental approaches.

Systematic laboratory experiments were conducted using freshly deposited cohesive sediments from various sites in the Port of Hamburg. The sediment samples were diluted to bulk densities ranging from 1050 to 1250 kg/m³ and analyzed with respect to critical shear stress and erosion rates. In addition, in-situ erosion experiments were performed in the tidal flats of the Elbe estuary at different times in order to capture the temporal variability in erosion characteristics. Complementary ex-situ experiments on extracted sediment cores were carried out both directly at the sampling site and in the laboratory to quantify the influence of sampling and transport on the results of the erosion experiments. All experimental investigations were accompanied by detailed analyses of the environmental conditions and sediment characteristics.

The results provide a thorough and nuanced insight into the governing mechanisms of cohesive sediment erosion. The laboratory experiments with harbor sediments indicate erosion thresholds of 0.03–0.31 N/m², decreasing erodibility with increasing sediment concentration, and an exponential increase in erosion rates with normalized excess bed shear stress. The parameterization of various mathematical models shows good agreement with recently proposed, largely physically based approaches for describing critical erosion thresholds and provides a quantitative basis for future numerical modeling efforts. The field investigations further highlight the

influence of hydrodynamic conditions on the properties and erodibility of tidal flat sediments, and indicate a reduction in erosion resistance of up to 60% associated with sampling and transport of sediment samples.

This study was conducted as part of the project ELMOD and funded by the German Ministry of Research, Technology and Space.

PhD Student

Yu, Xiao^{1*}, S. Balachandar¹, Andrew Manning²

Flocculation Dynamics in Vegetation Generated Turbulence using a Two-Phase Model

¹University of Florida; ²University of Plymouth; *yuxiao03@ufl.edu

A coupled CFD-DEM (Computational Fluid Dynamics – Discrete Element Method) framework was applied to study the flocculation dynamics of cohesive sediment in vegetation stem-generated turbulence. The vegetation stems were modelled as a periodic array of circular cylinders. Initially, monodispersed spherical sediment particles were introduced into the computational domain, and flocs forms due to particle collisions by turbulence. The high fidelity CFD model resolves all the turbulent scales. The drag force model by Kim & Lee was implemented, which considers the shielding effects from neighbor particles. The adhesive contact mechanics JKR model was implemented to account for the attractive forces among cohesive sediment particles, and the rolling friction was used to capture the floc restructuring by turbulence. Vegetation stem-generated turbulence shows strong anisotropy and spatial heterogeneity, with quasi-2D coherent vortex shedding from the circular cylinders. Preferential accumulation occurs as large flocs are absent in cores of the large quasi-2D turbulent coherent structures. Floc breakup primarily occurs in regions of high strain rate due to turbulent shear, instead of mechanical collision between flocs and the vegetation stems. Large anisotropic turbulent eddies simply transport the flocs around, and small-scale nearly isotropic eddies control the flocculation dynamics. Therefore, results from homogenous isotropic turbulence studies can represent turbulent effects on flocculation dynamics and resulting floc size spectra reasonably well. The shielding effects are critical for the modeling of the flocculation dynamics. Without the shielding effects, the model fails to capture the preferential accumulation and orientation of the flocs, which in turn affects the aggregation, breakup and restructuring processes and hence the equilibrium floc size and shape distributions.

Zhang, Naiyu^{1*}, Qing He¹, Charlotte Thompson², Ian Townend²

Microbial Colonization Increases Drag Acting on Suspended Sediment

¹State Key Laboratory of Estuarine and Coastal Research, East China Normal University, Shanghai, 200241, China; ²School of Ocean and Earth Science, National Oceanography Centre, University of Southampton, Southampton, SO14 3ZH, UK; *nyzhang@sklec.ecnu.edu.cn

Microbial colonization of fine-grained sediment particles is a globally pervasive phenomenon in aquatic environments. This process transforms individual sediment

grains into complex aggregated structures, altering almost the entire cycle of sediment transport. The transport of these microbially colonized structures is fundamental to continental landscape formation and the fluxes of particulate matter (nutrients, carbon and pollutants) across Earth's surfaces. Hence accurately incorporating the effects of microbial colonization into transport models is critical for understanding and predicting these processes. To date, most studies have focused on microbially-induced changes in aggregate size to account for the microbial influences on sediment transport. However, this framework assumes that aggregates experience fluid drag equal to smooth or idealized shapes, which overlooks a crucial factor: the intricate and varied morphologies of these microbially colonized sediment aggregates. To address this knowledge gap, we combine X-ray microcomputed tomography with computational fluid dynamics simulations to characterize aggregate morphology at high spatial resolution and quantify its relationship with drag. Our results show that microbial colonization complicates aggregate morphology at fine scales and enhances drag by a factor of 1-3 relative to smooth surfaces. We further propose a morphology-corrected drag law that accounts for this complexity, reconciling the differences in drag across diverse aggregates collected from rivers, coastal wetlands and estuaries. Our findings reveal that even aggregates with the same gross shape, as defined by elongation and flatness, can exhibit distinct transport behaviors due to small-scale morphological differences. These results underscore the importance of incorporating fine-scale morphological features into sediment transport predictions, marking a shift from a focus solely on gross particle properties to a more detailed consideration of micro-scale morphology.

POSTERS

Claar, Caleigh^{1*}, Jeffrey Nitttrouer¹, Kyle Strom²

Dynamics of Flocculated Mud Transport and Impact on Sediment-Diversion Efficiency in the Lowermost Mississippi River System

¹Texas Tech University; ²Virginia Tech University; *cclaar@ttu.edu

Coastal Louisiana is experiencing rapid wetland loss driven by reduced sediment supply, subsidence, and sea-level rise. Sediment diversions have emerged as a primary restoration strategy to reconnect the Mississippi River to its delta plain; however, existing models prioritize sand transport and largely undervalue the role of flocculated mud transport. For example, recent studies have demonstrated that fine-grained sediment (silt and clay), which comprises 80% of the Mississippi River sediment load, is transported predominantly as flocculated aggregates (flocs), which exhibit enhanced settling velocities and behave similarly to bed-material load under certain hydrodynamic conditions. Moreover, floc size is dynamic and known to be impacted by a suite of variables, including turbulence regime, organic matter content, water temperature,

suspended sediment concentration, and salinity, all of which vary across the fluvio-deltaic continuum represented in the Mississippi River. The degree to which such variables affect flocc dynamics through sediment-diversion analogs is poorly constrained, and addressing this knowledge gap offers an opportunity to improve and validate existing land-growth models.

The objective of this study is to investigate the dynamics of flocculated mud transport and related implications for sediment diversion efficiency in the lowermost Mississippi River system. Field measurements are conducted across natural and engineered diversion analogs, including the Old River Control Complex, Wax Lake Delta, Neptune Pass, and the West Bay Sediment Diversion. Floc size, concentration, and vertical distribution are quantified using in situ imaging instrumentation (FlocARAZI), while hydrodynamic conditions are characterized using an Acoustic Doppler Current Profiler (ADCP). Complementary water sampling constrains sediment properties, organic content, and water chemistry. This suite of data provides the opportunity to constrain flocculation dynamics and therefore sediment transport dynamics of mud across regions where water flows out of the mainstem Mississippi River channel.

We hypothesize that turbulence is the dominant control on floc size and stability, and that diversion-induced turbulence fragments flocs, reducing mud retention efficiency. By integrating field observations with sediment transport models, this research will improve predictions of mud deposition and optimize diversion design and operation. Results will provide critical insights for coastal restoration strategies and enhance the effectiveness of sediment diversions in building and sustaining wetlands.

MS Student

Girardeau, Brittany^{1*}, Earl Hayter²

Fluid Mud Data Collection and Analysis

¹USACE/South Alabama/SMART; ²ERDC; *Brittany.E.Girardeau@usace.army.mil

The Gulfport Harbor Federal Navigation Channel Integrated Feasibility Report with Environmental Assessment (Study) is ongoing with the United States Army Corps of Engineers (USACE). This Study required an analysis to predict the navigation channel's existing and proposed shoaling rates. A key challenge in this project is the presence of fluid mud throughout the channel, which introduces uncertainty in sediment transport dynamics and may adversely affect channel operations.

Fluid mud refers to a highly concentrated suspension of fine-grained sediment in which settling is substantially hindered by the proximity of sediment grains and flocs (McAnally et al., 2007a). Fluid mud can form into thick layers, which can impede navigation due to its rapid accumulation where the capacity of available dredges to keep the channel clear is exceeded. These problems caused by fluid mud have been documented for several ports around the world. The formation and transport of fluid

mud has been modeled in 1-, 2-, and 3-dimensional models (e.g. Yan and Hayter, 1994), but these models and analyses were based on empirical relationships focused on small data sets (McAnally et al., 2007b).

This research will aim to improve the predictability of fluid mud formation, movement, and liquefaction using a combined effort of field data collection, laboratory experiments, and numerical modeling. The objective is to develop, calibrate, and validate a new fluid mud transport module using the results from the field and laboratory components of this study. This module will be incorporated into the existing Environmental Fluid Dynamics Code (EFDC+) Explorer Modeling System (EEMS). [EH1.1] Although this module will be validated for a specific location, developing the module and a validation method will help us have a better understanding of fluid mud processes and an improved ability to predict the presence of fluid mud, [EH2.1] and how to mitigate its impacts on ports globally.

The fluid mud data to be included in this poster presentation will be collected in June from the Federal Navigation Channel leading to the Port of Gulfport, Mississippi, then post-processed and analyzed before INTERCOH. These data include the following: vertical density profiles, vertical velocity profiles, core samples, sediment samples, velocity at sample locations, conductivities, temperatures, depths, turbidities, and sediment settling velocities. All of this data will be collected for both a spring and a neap tide.

The poster will include the analyses to be conducted on the collected data and results from the subsequent laboratory experiments, as well as a description of the fluid mud module to be developed over the subsequent two years of this study.

PhD Student

Guity Zapata, Joel^{1*}

Fine Sediment Dynamics and Land-Based Coastal Pollution in Estuarine and Coastal Environments of the Continental Honduran Caribbean: Implications for Integrated Coastal Management

¹University of Cadiz; *joelguityhn@gmail.com

The continental Caribbean coast of Honduras is a strategic socio-ecological system in the western Caribbean, where estuaries, coastal lagoons, mangroves, beaches, seagrass beds, and coral reefs are tightly connected to watershed processes and community livelihoods. In this region, land-based pressures associated with unplanned urban growth, inadequate wastewater treatment, agroindustrial expansion, and poor solid waste management contribute to the delivery of fine sediments, nutrients, organic matter, and debris into estuarine and coastal environments. While coastal pollution has been increasingly recognized as a major environmental threat, the role of fine-grained sediments as transport media, sinks, and remobilization agents of pollutants remains underexplored in the continental Honduran Caribbean.

This contribution proposes an integrated analysis of the links between cohesive sediment dynamics and land-based coastal pollution, building on previous research on coastal contamination and socio-environmental diagnosis in Honduras, as well as on the DPSIR framework as a systems-oriented analytical tool. The study adopts a source-to-coast perspective to examine how watershed land-use change, erosion, runoff, and hydrosedimentary processes influence the transport, deposition, and resuspension of contaminated fine sediments in critical estuarine and nearshore settings. Key pressures include untreated domestic and industrial wastewater discharges, agricultural runoff enriched with nutrients and agrochemicals, and river-borne solid waste reaching beaches, mangroves, estuaries, and shallow marine habitats.

The paper argues that cohesive sediments are not only relevant for shoreline and estuarine morphodynamics, but also function as vectors of environmental degradation by facilitating the accumulation and redistribution of microbiological contaminants, excess nutrients, plastics, and other land-derived materials. These interactions are especially significant in low-energy estuarine and lagoonal environments, where sedimentation processes can intensify water quality deterioration and habitat stress. Such dynamics have important ecological and social consequences, including impacts on artisanal fisheries, public health, tourism, and the resilience of coastal and Indigenous communities whose livelihoods depend on healthy marine and coastal ecosystems.

This case study contributes to broader discussions on sediment-related coastal processes by linking physical transport mechanisms, land-based pollution, and multiscalar coastal governance. It highlights the need for integrated watershed–estuary–coast management, standardized environmental monitoring, and policy responses that better connect sediment dynamics with coastal conservation and sustainability in the Honduran Caribbean.

PhD Student

Hiteh, Mojtaba^{1*}, Cameron P. Lott², Xiao Yu¹, S. Balachandar²

Physics-Informed Machine Learning Parameterization of Drag Force in Fractal-Like Sphere Aggregates (Flocs) under Stokes Flow

¹University of Florida, Department of Civil and Coastal Engineering; ²University of Florida, Department of Mechanical and Aerospace Engineering; *mojtaba.hiteh@ufl.edu

Cohesive sediments in rivers, estuaries, and coastal areas aggregate and form flocs. Flocculation processes determine floc size and shape distributions, and hence settling behavior. To understand the flocculation dynamics of cohesive sediments, two-phase Euler-Lagrangian model that can capture both fluid-particle and particle-particle interactions is widely used. In two-phase model, the accurate prediction in bulk floc properties, such as average floc size and floc settling velocity depends strongly on the drag force parameterization. Stokes drag law with a correction of

sediment concentration is commonly used for simplicity; however, it does not consider the flow sheltering by neighboring particles, which could significantly underpredict the sedimentation rate estimation of flocs.

A novel physics-informed machine learning technique was developed to predict the drag force on individual primary particles within a floc accurately and efficiently. We used the analytical solution by Filippov to obtain the drag forces on each individual primary particle in the floc of N spheres. The dataset includes eight floc realizations covering different N (size) and D_f (fractal dimension), subjected to an ambient flow velocity of unit magnitude sampled in 10 random directions, yielding 192,000 particle samples. In the proposed model, the total drag on each particle is decomposed into a unary Stokes contribution and a binary correction representing pairwise neighbor interactions. The binary correction is learned using a neural network architecture with two subnetworks, one takes the floc-scale descriptors N and D_f , and the other takes pairwise relative positions and the imposed flow direction. To account for higher-order neighbor effects, model variants follow the heuristic empirical approach of Kim and Lee, where two-particle interactions are corrected based on three-particle interactions. The machine learning model can predict both the drag force on individual primary particles and the total drag on the floc accurately and efficiently. This suggests strong potential for predicting breakup/restructuring processes and floc settling velocity accurately, which are critical for cohesive sediment transport studies. In five-fold cross-validation, the binary-interaction model with a learned correction to neighbor contributions achieves the best performance for individual drag prediction with R^2 values ranging from 0.97 for smaller flocs ($N=32$) to 0.87 for larger flocs ($N=256$). For total floc drag, the model also shows good agreement with the Filippov ground truth.

PhD Student

Kosako, Taichi^{1*}, Yasuyuki Nakagawa²

Multi-Frequency Acoustic Backscatter Characteristics of Fluid Mud Layers During Laboratory Sedimentation

¹Port and Airport Research Institute, Japan; ²National Institute for Land and Infrastructure Management, Japan; *kosako@p.mpat.go.jp

In ports where fluid mud accumulates, the definition of the bottom becomes ambiguous due to the dynamic nature of interfaces between water, fluid mud, and consolidated sediment, making the assessment of nautical depth challenging. In such environments, the concept of nautical depth based on rheological properties of fluid mud, such as bulk density and yield stress, has been implemented in some overseas ports. However, its applicability in Japanese ports has not yet been sufficiently investigated. In addition, these physical properties are typically obtained using intrusive measurement techniques, such as tuning fork sensors, which limit the ability to capture spatio-temporal variability. Acoustic methods offer strong potential as a complementary

approach to conventional intrusive techniques, while their effective use requires integration with measurements of rheological and other physical properties.

In this study, controlled laboratory experiments were conducted in a column to investigate the acoustic response of fluid mud layers using mud samples collected from a Japanese port. Vertical profiles of multi-frequency (28, 38, 68, and 200 kHz) acoustic volume backscatter intensity (SV) were measured during the sedimentation of high-concentration mud in a 1.8 m seawater column. The relationship between the behavior of the mud–water interface (lutocline) and the acoustic response was analyzed.

The results showed that an increase in SV was observed near the lutocline at all frequencies, while the vertical distribution characteristics exhibited clear frequency dependence. The high frequency (200 kHz) showed a sharp increase in SV closely associated with the lutocline, whereas the lower frequencies (28 and 38 kHz) consistently exhibited peaks in SV at deeper locations, with two-step increases observed under certain conditions. Furthermore, at the lower frequencies (28 and 38 kHz), the maximum SV within the fluid mud layer increased in correspondence with the increase in bulk density associated with the downward movement of the lutocline. The intermediate frequency (68 kHz) exhibited characteristics between these two regimes. These findings suggest that acoustic backscatter responds to the vertical structure and density variation of fluid mud layers, with different physical mechanisms depending on frequency. High frequencies are more sensitive to interface scattering associated with density gradients, whereas lower frequencies may be more influenced by volume scattering within the fluid mud layer, reflecting its internal structure, which may be related to microstructural features and remains not yet fully understood under fluid mud conditions. This implies that, particularly at lower frequencies, acoustically detected strong scattering layers do not necessarily coincide with the location of maximum density gradient. These findings are expected to contribute to improved detection of fluid mud and more reliable nautical depth assessment.

Miller, Emily^{1*}, Madeline Foster-Martinez¹

Assessing Coastal Restoration Impacts in the Lower Mississippi River Using Satellite-Derived Sediment Transport Metrics

¹University of New Orleans; *emmille2@uno.edu

The Lower Mississippi River (LMR), once contained in wide alluvial valley reaches, has since undergone extensive anthropogenic modification that altered the historic hydrologic and sediment transport regimes. Reduced sediment delivery to adjacent coastal wetlands has contributed to accelerated rates of land loss and increased vulnerability to sea level rise. Many restoration initiatives in Louisiana have effectively harnessed the sediment load carried through crevasses of the LMR by retaining the sediment needed to increase the elevation in the adjacent coastal bays

and build land. Maximizing success of future restoration projects requires well informed, cost-effective, reliable mechanisms to quantify suspended sediment concentration (SSC) and sediment transport through distributary channels before projects are implemented. In-situ methods are often costly, labor intensive, time consuming, limited in spatial scale, and logistically hazardous in the high flow channel environments where SSC is highest. Satellite-based remote sensing provides a potential alternative for monitoring turbidity and SSC with high frequency datasets and captures spatiotemporal variations in transport processes. The limitations of in-situ methods drive a need to apply efficient and precise remote sensing technology to monitor environments along the LMR. However, the accuracy of remotely-sensed SSC estimates in highly turbid waters, such as the LMR, are still poorly constrained. Coarse spatial resolution and large swath sizes can reduce classification accuracy in narrow channels due to mixed or misclassified water pixels.

This study evaluates the performance of two radiometric satellite datasets for estimating SSC in the LMR environment, Planet Scope and Sentinel-2. Satellite observations are calibrated using in-situ measurements collected from May-August 2026 within a man-made distributary channel on the east bank of the LMR influenced by flow through Ostrica Pass. Two optical back scatter sensors were deployed in adjacent channels along with ADCPs. Water samples are collected for calibration to SSC, sediment mineralogy is determined through x-ray diffraction (XRD), and grain size distributions may be analyzed using laser diffraction.

The datasets will be incorporated into a semi-empirical machine learning model to evaluate SSC detection performance. The dataset yielding the highest precision and accuracy will be applied to assess SSC trends in Bay Denesse, a nearby receiving basin extensively modified by restoration activities. This analysis will improve understanding of sediment transport and retention associated with coastal restoration activities in the LMR deltaic system.

MS Student

Pedocchi, Francisco^{1*}, Victoria Giovannone², Micaela Bellón², Fernanda Maciel², Romaric Verney³

Correction of Turbidity Effects on Chlorophyll-a Fluorescence Measurements in Estuaries

¹Instituto de Mecánica de los Fluidos e Ingeniería Ambiental, Universidad de la República, Uruguay;

²IMFIA, Facultad de Ingeniería, Universidad de la República, Uruguay; ³IFREMER, DYNECO/DHYSED, France; *kiko@fing.edu.uy

In estuarine and coastal environments, accurately monitoring phytoplankton biomass is essential, given its critical role on cohesive sediment dynamics. In situ chlorophyll-a fluorescence is one of the most widely used proxies for estimating phytoplankton biomass in monitoring programs. However, in highly turbid environments, suspended sediments alter the optical properties of the water column and introduce

systematic biases in fluorescence measurements. Light scattering and absorption by mineral particles can produce apparent increases in the detected signal, leading to overestimation of chlorophyll-a concentrations.

This study evaluates the influence of suspended sediments on chlorophyll-a fluorescence measurements and proposes a semi-empirical correction formulation derived from controlled laboratory experiments and analysis of field time series from the Río de la Plata estuary. Experiments were conducted using ECO Triplet sensors (WET Labs, USA), which simultaneously measure chlorophyll-a fluorescence and turbidity. Two experimental protocols were followed using a 30-liter opaque container filled with distilled water. In the first protocol, increasing concentrations of four sediment types (kaolin, quartz, brick dust, and estuarine mud) were added to characterize the sensor response to turbidity alone. In the second protocol, a fixed initial concentration of rhodamine was introduced to simulate a background fluorescence signal, and sediments were then added progressively to isolate the effect of turbidity on the measured signal. Field time series of chlorophyll-a fluorescence, turbidity, wave height, and salinity collected at the Río de la Plata between 2021 and 2025 were also analyzed.

Laboratory results show that in the complete absence of fluorescent substances, fluorescence signals increase systematically with turbidity, regardless of sediment type. They also show that in the presence of background fluorescence the magnitude of the interference varies with sediment type. Based on these findings, a semi-empirical formulation was developed that describes measured fluorescence as a function of true fluorescence, turbidity, and sediment-dependent correction coefficients. Application of this correction to field time series recorded at the Río de la Plata monitoring station successfully removed spurious fluorescence peaks associated with short-term sediment resuspension events, while salinity remained stable, confirming the absence of changes in water mass composition during those episodes.

These results demonstrate that turbidity-induced optical interference can substantially compromise chlorophyll-a fluorescence data quality in turbid estuarine environments, and underscore the need to incorporate systematic correction procedures in water quality monitoring programs operating in sediment-rich coastal and estuarine systems.

Penaloza Giraldo, Jorge^{1*}

Beyond Equilibrium: Toward Dynamic Class-Revolved Flocculation and Cohesive Sediment Transport

¹Virginia Institute of Marine Science; *japgg@vims.edu

Flocculation strongly influences cohesive sediment transport by modifying the floc-size distribution and, consequently, sediment settling velocity and vertical concentration structure. Previous work using a local-equilibrium flocculation framework showed that the balance between aggregation and fragmentation can substantially

affect sediment transport. However, local equilibrium assumes that the floc population has fully adjusted to the local environmental conditions, while natural coastal and estuarine environments experience temporal and spatial variations in turbulent shear and sediment concentration. Here, a transient, class-resolved modeling framework is developed to explicitly represent the time evolution of the floc population together with vertical sediment transport. The prognostic variables are the sediment mass concentrations associated with individual floc-size classes, which evolve through flocculation, settling, and turbulent diffusion. Flocculation is represented using the Population Balance Equation-based FLOCMOD, and coupling with vertical transport is implemented using a Strang-type splitting approach. FLOCMOD was also computationally optimized while preserving its original scientific formulation, substantially reducing the cost of repeated population-balance calculations and enabling simulations with a larger number of floc classes. Idealized simulations demonstrate that the cohesive sediment parameter $r=\alpha/\beta$, defined as the ratio between collision efficiency and shear fragmentation rate, controls both the magnitude and timescale of the transient response. For $r=2.5$, the floc population exhibits relatively modest increases in the mass-weighted mean settling velocity and approaches a near-steady condition comparatively rapidly, whereas for $r=10$, stronger floc growth produces substantially higher mass-weighted mean settling velocities, enhanced near-bed sediment accumulation, stronger vertical concentration gradients, and a longer adjustment toward a near-steady state. These results demonstrate that finite flocculation adjustment timescales can influence settling velocity and the transient vertical redistribution of cohesive sediment, providing a basis for evaluating the applicability of the local-equilibrium assumption under variable coastal and estuarine conditions.

Reinhardt, Jacob^{1*}, Kehui Xu¹, Samuel Bentley²

High Sediment Concentration Events and Fluid Mud Processes in an Interdistributary Bay of the Mississippi River Delta

¹Louisiana State University, Department of Oceanography and Coastal Science; ²Louisiana State University, Department of Geology and Geophysics; *jrein4@lsu.edu

The Mississippi River Delta is built upon the deposits of a bulk of both cohesive and non-cohesive sediments from the Mississippi River. Understanding sediment transport within the subaqueous portions of the Mississippi River Delta is crucial in predicting the future of the delta, including the high-sediment-concentration events. Fluid-mud formation is relatively common in cohesive sedimentary environments, including offshore of the Chenier Plain of southwest Louisiana; however, fluid-mud processes within the Mississippi River Delta Front have not been the focus of much study.

This study intends to examine sediment-transport processes in East Bay of the Mississippi River Delta. East Bay is a triangular interdistributary bay bounded by Southwest Pass and South Pass and is divided into two parts by a 10-km long

E-W-trending narrow and low barrier island. This study integrates newly collected data from optical sensors and a downward looking Acoustic Doppler Current Profiler (ADCP), along with previously collected data to potentially track fluid mud flows down-slope. Previously collected optical backscatter measurements (Campbell Scientific OBS-3A) in this setting have reached sensor saturation and exceeded limits of laboratory calibration measurements under highly turbid field conditions (likely $>> 10 \text{ g/l}$) in the lower water column. However, the use of OBS-5A will allow for the measurement of higher turbidities and the use of ADCP backscatter to calculate sediment concentration profile and to potentially track the flow of fluid mud formations within the bottom boundary layer.

PhD Student

Rodrigues, Sarah^{1*}, Luana Gallo¹, Marcos Gallo¹, Adriane Sena¹, Marcelo Di Lello Jordão¹, Susana Vinzon¹

Influence of Collision-Efficiency Parameterization on Oil-Particle Aggregation under Energetic Conditions at the Amazon River Mouth

¹Laboratório de Sedimentos Coesivos—LDSC, Departamento de Engenharia Naval e Oceânica, Universidade Federal do Rio de Janeiro, Rio de Janeiro 21941-909, RJ, Brasil; *sarah.skr@gmail.com

Oil-particle aggregation is a key process controlling the transport and fate of spilled oil in turbid environments, particularly where suspended sediment concentrations and hydrodynamic energy are high. In such systems, the interaction between oil droplets and fine particles may enhance oil retention in the water column or favor sedimentation, depending on the balance between collision frequency and attachment efficiency. A critical parameter in this process is the collision efficiency coefficient (α), which represents the probability that a collision between oil droplets and suspended particles results in aggregation. Despite its importance, many modeling approaches assume constant α , which may oversimplify aggregation dynamics under variable hydrodynamic conditions. This study evaluates the influence of constant and variable α parameterizations on oil-particle aggregation rates for representative scenarios at the Amazon River mouth, one of the most energetic and sediment-rich coastal systems in the world. Two representative points, P5 and P6, were used to reproduce contrasting environmental conditions along the estuary-shelf transition, incorporating differences in salinity, suspended sediment concentration, and hydrodynamic forcing. Three oils with distinct physical properties were considered: Oseberg Blend (light), Kuwait (medium), and IFO-380LS (heavy). Aggregation rates were computed as $R = \alpha \cdot \beta$, where β is the collision kernel and α is either fixed or dynamically modulated. The results show that the parameterization of α exerts strong control on effective aggregation rates. Under constant α , aggregation rates increase monotonically with particle size and hydrodynamic energy, producing relatively smooth responses across oils and sampling points. In contrast, the variable α formulation yields strongly non-linear behavior. Under low and intermediate

energy conditions, α remains sufficiently high to sustain effective aggregation. However, under high-energy conditions, α decreases sharply, causing a collapse in effective aggregation rates despite elevated collision frequencies. This indicates a transition from a collision-controlled regime to an adhesion-limited regime, where turbulence and shear reduce attachment efficiency and aggregate stability. Spatial differences between P5 and P6 were also observed, with P6 generally showing higher aggregation rates, due to a more favorable combination of suspended sediment and salinity conditions. Oil properties further modulate this response, with IFO-380LS systematically producing the highest aggregation rates and Oseberg Blend the lowest. Overall, the results demonstrate that assuming constant α may substantially overestimate oil–particle aggregation under energetic conditions. Incorporating variable collision efficiency is therefore essential for improving predictions of oil fate in highly dynamic muddy environments such as the Amazon River mouth.

Schlottman, Stephen^{1*}, Kelsey Fall², Tom Hsu², Kyle Strom¹

Measurement of Floc Settling Velocities Within a Mixing Tank

¹Virginia Tech, Blacksburg, VA; ²University of Delaware; *sschlottman25@vt.edu

Knowledge of floc settling velocities is critical for accurate prediction of mud transport and deposition processes in river and coastal waters. Mud floc settling velocity depends on the size, composition, and packing structure of the particles that make up the flocculated aggregates. All of these factors can vary from mud to mud, from season to season, and even from location to location within a particular system. For this reason, it is necessary to often measure both the size and settling velocities of flocculated suspensions to fully characterize the transport characteristics of the mud. However, measuring mud settling velocity is extremely difficult. Classic methods for measuring the settling velocity of individual sands and gravel in settling columns is difficult to mimic for mud flocs due to the small, fragile nature of flocs and small recirculatory currents in the settling column that have velocities on the order of the settling velocities of the flocs themselves. Furthermore, introduction of a suspension of flocs to a settling column via a pipette inevitably produced concentration gradients that lead to flocs settling en masse due to the increased density of the introduced suspension relative to the ambient receiving fluid of the column. In this study, we present a method for measuring the settling velocity of a distribution of floc sizes formed within mixing tanks. The method uses images taken of the suspension to measure the distribution of floc sizes in suspension, and then fits the total decaying concentration time series to a polysized solution of the advection diffusion equation considering mixing. With this method, the floc fractal dimension is the calibration parameter for the fit. The method allows for rapid measurement of the floc settling velocity (and hence density) as a function of size for a suspension as a whole without needing to transfer the flocs to another apparatus for measurement. The method was developed and tested using synthetic particles of

known density and by comparison with the Particle Imaging Camera System (PICS) and associated PIV/PTV software for measuring settling velocity.

MS Student

Sena, Adriane^{1*}, Sarah Karoline Rodrigues¹, Marcelo Di Lello Jordão¹, Marcos Nicolas Gallo¹, Susana Beatriz Vinzon¹

Experimental Investigation of Fine-Sediment Flocculation Kinetics and Equilibrium in the Amazon Estuary

¹ Federal University of Rio de Janeiro (UFRJ), COPPE, Ocean and Naval Engineering Program;

*adrianesena@oceanica.ufrj.br

The flocculation of suspended fine sediments is a fundamental dynamic process governing the transport and deposition of cohesive material in aquatic environments. This phenomenon, characterized by the balance between particle aggregation and disaggregation, determines the size and density of aggregates, thereby directly influencing the formation of muddy deposits in the Amazon estuary. This study aimed to simulate, under controlled laboratory conditions, the flocculation process of sediments collected from the mouth of the Amazon River, evaluating the influence of suspended sediment concentration (SSC) and shear rate (G) on floc formation kinetics and equilibrium floc diameter. Bottom sediment collected from the Estuarine Turbidity Maximum Zone (ETMZ) of the Amazon River, sieved to $<63\ \mu\text{m}$, was used. The experimental setup consisted of a closed-loop system integrating a jar-test flocculator, a peristaltic pump, and a laser diffraction analyzer (Malvern Mastersizer 2000). The procedure was divided into two stages: (1) initial sample dispersion at 4000 rpm for 3 minutes to ensure complete disaggregation; and (2) continuous monitoring of flocculation under constant shear (40–50 rpm) and at different ascending concentrations for up to 7 hours. Floc size was characterized by the suspension diameter. The experiments showed that the time required to reach equilibrium diameter was approximately 5 hours. A bimodal volumetric distribution was observed, indicating the growth of microflocs and macroflocs at the expense of the reduction of primary particles. Laboratory tests also indicated that floc size varied inversely with both shear rate and suspended sediment concentration. The closed-loop methodology enabled quantification of the influence of physical variables on floc formation in sediments from the Amazon River. The inverse relationship between floc size and concentration observed in the laboratory suggests that natural-system dynamics are strongly influenced by resuspension processes that may mask aggregation kinetics. Temporal analysis, interpreted in light of the Winterwerp model, indicated the existence of different kinetic regimes among the tested conditions. Most experiments showed net floc growth up to the equilibrium diameter, whereas the 0.2 g/L condition displayed behavior consistent with the breakup branch. Model fits also indicated variation in the characteristic timescale of the process (T') among conditions, with faster responses at

50 rpm for 0.3–0.4 g/L. The kA/kB ratio, used as a preliminary indicator of the balance between aggregation and breakup, remained low at 40 rpm and increased at higher concentrations under 50 rpm, suggesting greater sensitivity of flocculation equilibrium to the combined effects of SSC and shear. The parameters obtained, including the aggregation and breakup coefficients, are essential for calibrating numerical sediment transport models for the Equatorial Margin.

Styles, Renee^{1*}, Anthony M. Priestas¹, S. Jarrell Smith¹

Evaluation of Best Practices for Cohesive Sediment Size Distributions by Laser Diffraction Methods

¹US Army Engineer Research and Development Center; *Renee.M.Styles@usace.army.mil

Laser Diffraction Methods (LDM) for determining sediment size offer considerable time and cost savings compared to conventional sieve and hydrometer methods. While the cost savings of the LDM are substantial (tenfold reduction in processing time), inconsistencies with the conventional methods arise by a combination of differences in measurement methods, disaggregation of clay minerals, and light scattering interactions with organics and polydisperse particle suspensions. This poster presents the results of controlled laboratory examinations of best practices in determining sediment size distributions from natural sediment mixtures with varying clay content and clay mineralogy. Recommendations are presented on the appropriate chemical dispersant dosing, sonication treatment, organic matter removal, and sample obscuration. Special attention is given to the limits of the LDM for bi-modal sediment mixtures with small fractions of fine or coarse constituents. The conclusions of this work are being prepared into a best practices manual for sizing of cohesive and mixed sediments using the LDM.

Witt, Markus^{1*}, Markus Kreklau²; Justus Patzke¹; Peter Fröhle¹

Near-Field Dynamics of Discrete Dredged Material Discharge Events in the Elbe Estuary: Quantifying Deposition Fraction and Plume Evolution

¹Hamburg University of Technology; ²Federal Waterways Engineering and Research Institute (BAW); *markus.witt@tuhh.de

Dredging and relocation of sediments are essential to maintain navigable waterways and port access in many estuaries. The relocated volumes can significantly influence long-term morphological evolution and therefore need to be represented in numerical models. In the Elbe estuary, approximately 8 million m³ of sediment per year were dredged in the Port of Hamburg area between 2013 and 2018 and relocated to designated sites. In morphodynamic simulations, relocation processes require parameterization, typically based on limited empirical data, as dedicated field measurements of near-field processes during discharge at relocation sites are scarce. This study aims to quantify (i) the spatiotemporal evolution of the suspended sediment plume, (ii) the deposition fraction and resulting changes in bed morphology, and (iii) the sediment mass balance for individual discharge events.

Two measurement campaigns were conducted at the relocation site “Neßsand”, where the water depth was about 10 m. In total, nine discharge events of a hopper dredger with a capacity of 3,500 m³ were monitored. The dredged material consisted predominantly of fine sediments (> 80% silt and clay). All discharges were carried out during ebb tide at flow velocities of up to 1.5 m/s. The spatiotemporal evolution of the sediment plume was captured using two survey vessels equipped with ADCP systems calibrated for suspended sediment concentration. The plume’s surface signature was mapped by LiDAR-equipped drones. The relocation site was surveyed before and after each discharge event using a multibeam echosounder, sediment echosounder, and a density probe to quantify bathymetric changes and the bulk density of the deposited material.

The results reveal that at a distance of around 100 m from the discharge location, the plume was detectable for about 15 minutes, with suspended sediment concentrations of up to 5 g/L. Based on bathymetric differences derived from multibeam surveys and the in-situ density measurements, the deposited sediment volume and mass were quantified. Within the immediate vicinity of the discharge (area: 120 × 60 m), about 10% of the relocated sediment volume was deposited on average. Expanding the analysis to a larger area (280 × 160 m), this value increased to approximately 20%. The resulting deposits exhibited a characteristic morphology, with a central depression surrounded by a ring-shaped accumulation. Overall, the sediment mass balance indicates a deposition fraction of approximately 20% under the observed conditions, while about 80% of the discharged material remained in suspension. The measurements provide valuable validation data for numerical models and contribute to an improved process understanding relevant for sediment management and environmental assessment.

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PhD Student

Zhao, Tian^{1*}, Mead Allison¹

Salt Wedge Influence on the Floc Dynamics in the Lower Mississippi River

¹Department of River-Coastal Science and Engineering, Tulane University; *tzhao6@tulane.edu

The salt wedge of the Lower Mississippi River (LMR), intruding from the Gulf of Mexico through Southwest Pass into the main channel, is of major socioeconomic and geomorphic importance. Its upstream migration can threaten the drinking water security for river-adjacent communities, while the associated stratification influences sediment trapping and the delivery of land-building material to the rapidly degrading Birdsfoot Delta through flocculation. Recent observations (e.g., Osborn et al., 2023) indicate that fine sediment in the lowermost freshwater LMR can already occur as flocs before

encountering seawater, suggesting that the key question is not simply whether salinity initiates flocculation, but how salt-wedge stratification modifies pre-existing freshwater flocs. To date, the effects of the freshwater-to-salt-wedge transition on floc size, shape, and settling remain poorly understood. This knowledge gap limits our ability to predict whether fine sediment is retained within the Birdsfoot Delta or exported offshore, affecting morphodynamic and socioeconomic assessments of sediment dynamics, deltaic land loss, and water-resource vulnerability in LMR.

To determine how salt-wedge stratification modifies an already flocculated freshwater sediment supply, building upon Smith and Friedrichs (2015), we collected seasonal CTD, turbidity, and ADCP profiles in the LMR to resolve the temporal evolution of flow and salinity structure across different stages of salt wedge development, from weak or absent stratification to fully-developed salt wedge conditions. These measurements provide the hydrodynamic context for interpreting concurrent vertical profiles of floc geometry (e.g., aggregate size and shape), acquired with a submersible digital holographic camera (Sequoia LISST-Holo2). By pairing hydrographic observations with direct particle imaging, this study characterizes particle-scale sediment structure in relation to the evolving salt wedge, providing information that cannot be inferred from bulk turbidity measurements alone.

The paired observations are used to evaluate how increasing stratification modifies cohesive sediment aggregation, suspension, settling, and trapping. Particular attention is given to whether salt wedge development promotes larger or more irregular aggregates, alters the vertical distribution of floc size and shape, or changes the coupling between suspended sediment concentration and particle geometry. These observations provide process-level constraints for representing flocculation and fine sediment retention in LMR morphodynamic models. More broadly, this work helps bridge lower-river salt wedge processes with river-to-offshore sediment fate assessments by constraining whether fine sediment is retained within the deltaic receiving area or exported to the adjacent Gulf seabed, thus supporting improved projections of sediment dynamics, deltaic land loss, restoration planning, and water-resource vulnerability along the LMR.