Activity report on the project "*Microplastic concentration in sediments and waters of Matagorda and San Antonio Bays: Initial assessment and mitigation plans*"

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Period: January 1st 2024 to March 31st 2024 – Continuation of laboratory microplastics separation and description of filtered material, analyzing the data collected on Colorado Delta.

During the quarter of January to March 2024, we continued the work on separation of microplastics from sediments and opened all cores collected in previous field campaigns. More time was given to the new data collected in December 2023.

The previous built maps of sediment grainsize, TOC (total organic carbon) and microplastics have been updated with new lab results. The model for long-term bay sediment accumulation from the historical bathymetry map was refined.

Field Work in December 2023

Field campaign in the area of the Colorado River Delta, in the easter part of the Matagorda Bay have been undertaken. During the week-long field work we collected sidescan, & CHIRP data to better understand the bathymetry and sedimentation in the Colorado Delta, and also got sediment grab samples to analyze for microplastic content of the river derived sediments that are accumulating in the bay (**Figures 1-2**). The scope of the data collection is to better understand the sediment and microplastics dispersal from the Colorado River into the Matagorda Bay. Microplastic analyses for these new samples is still ongoing.

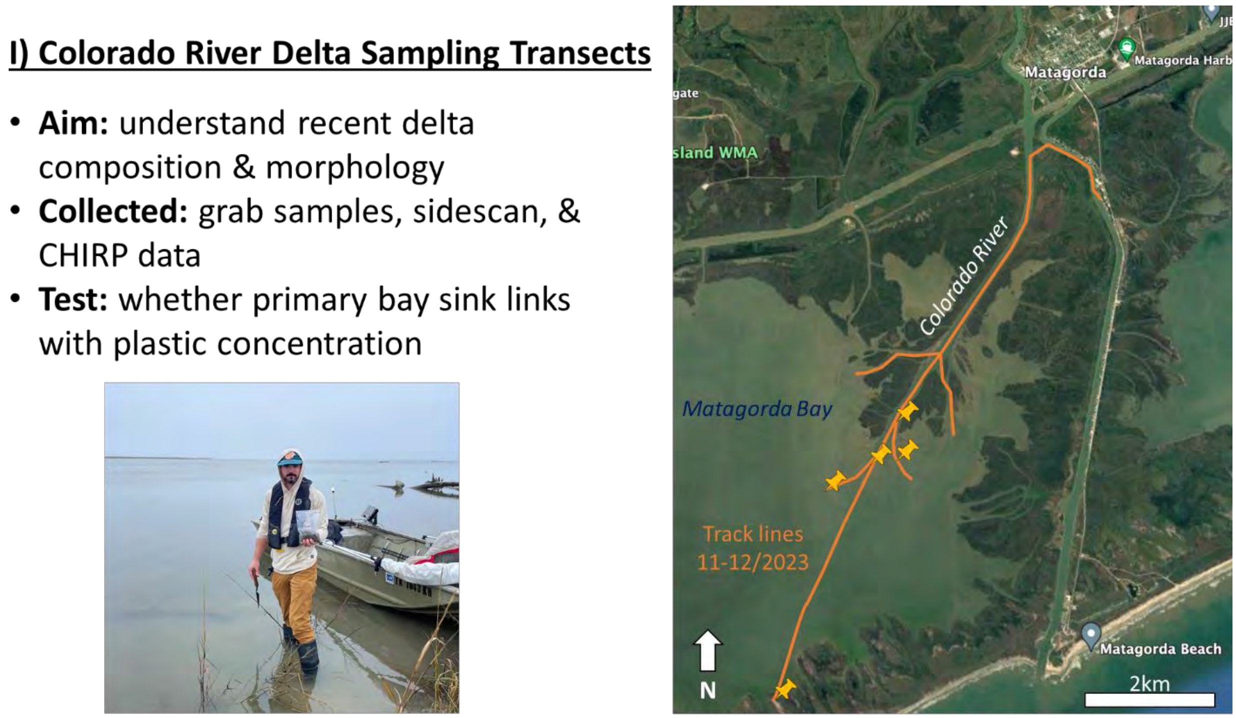

Figure 1. Data collected during December 2023 field work. Lower left photo show sediment data collected in delta front area of Colorado. On the right the lines of Chirp data and sediment sample locations.

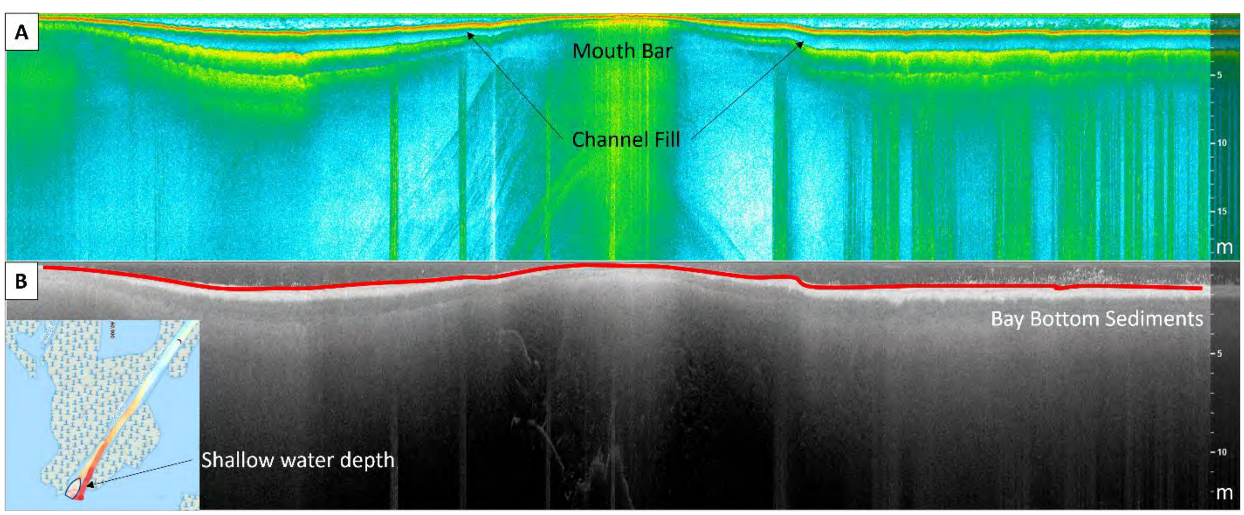

Figure 2. Example of CHIRP (A) and Downscan sonar (B) data collected along the Colorado Delta distributary channel.

During this period, microplastic concentrations and TOC analysis was completed on all surface sediment samples (**Figure 3A**). Samples include bay grab sediments and push core tops, as well as shoreline transects from Lavaca Bay and Matagorda Peninsula. Updated microplastic results show higher concentrations near Port Lavaca and proximal to the Colorado River mouth.

Total Organic Content for each of the surface samples was completed and spatially interpolated to compare with the last comprehensive study by McGowan 1979 (**Figure 3B**). TOC results illustrate higher values proximal to the Colorado River mouth and near the center of Matagorda Bay. These results are similar to the previous study.

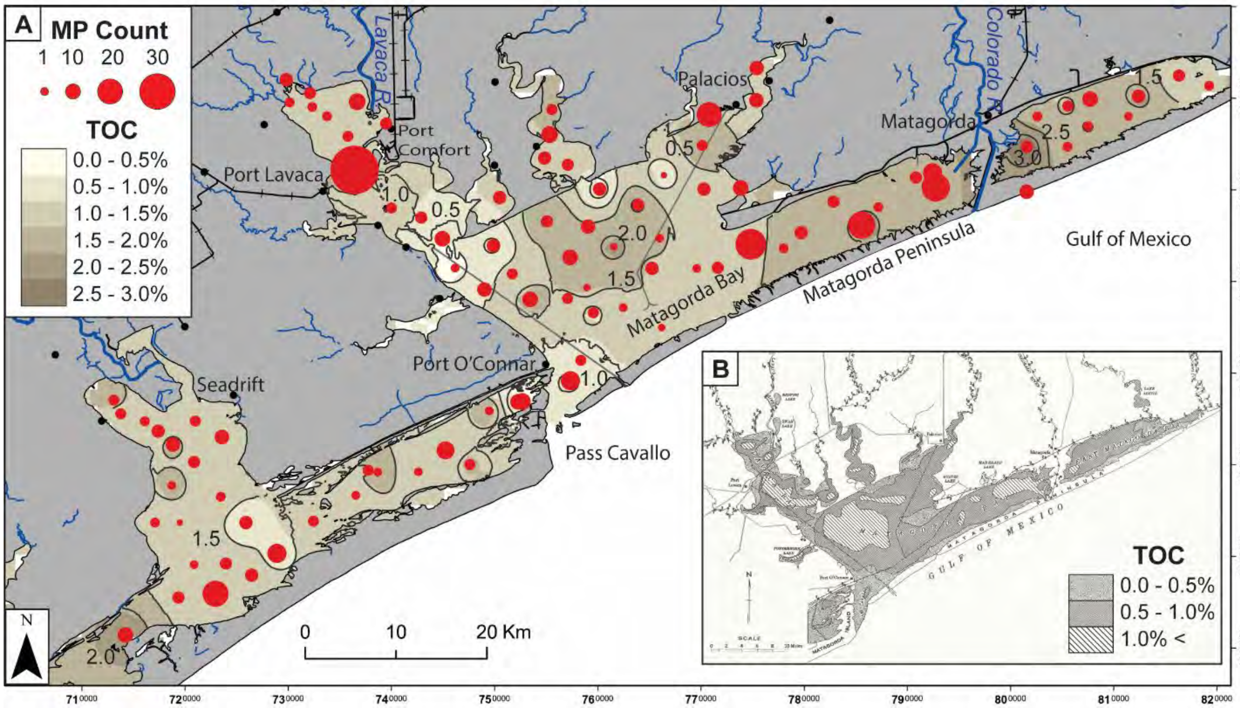

Figure 3. A) Total Organic Content and microplastic distribution map from bay sediment samples. B) Previous TOC map (modified from McGowan, 1979).

Long-term (over 100 years) sediment accumulation in Matagorda Bay using historical bathymetry maps suggests a highly dynamic bay that had parts which preserved the same depth or even got deeper (**Figure 4**). Long-term sediment accumulation patterns (1888-2024) indicate deposition associated with the modern Colorado River diversion and orientation of prevailing winds, as well as locations of dredge spoils from the Matagorda ship channel and Intercoastal waterway. Static bed elevation within the bays is postulated to be linked with sea level rise, which is documented to have increased by 20 cm over the same time period (**Figure 4B**). Net increase in water depth is hypothesized to be linked with subsurface structures and fluid extraction, where depth changes form linear features in proximity to known growth faults and developed oil and gas fields (**Figure 5**). For example, a known growth fault on Matagorda Peninsula studied by Feagin et al., (2013) linked the 40 year 0.75 m displacement with fluid extraction from the salt dome field in East Matagorda Bay. Further, enhanced subsidence may be associated with deposition by the Colorado River, where rapid sediment loading may activate preexisting growth faults. Historical seaward shoreline retreat along the barriers, coupled with net deepening along back-barrier shorelines may also indicate that these barriers are undergoing subsidence. The implications of enhanced subsidence along active land-building areas (deltas) and coastal armoring features (barriers) subjects coastal populations to elevated risk of inundation by storms and future sea level rise.

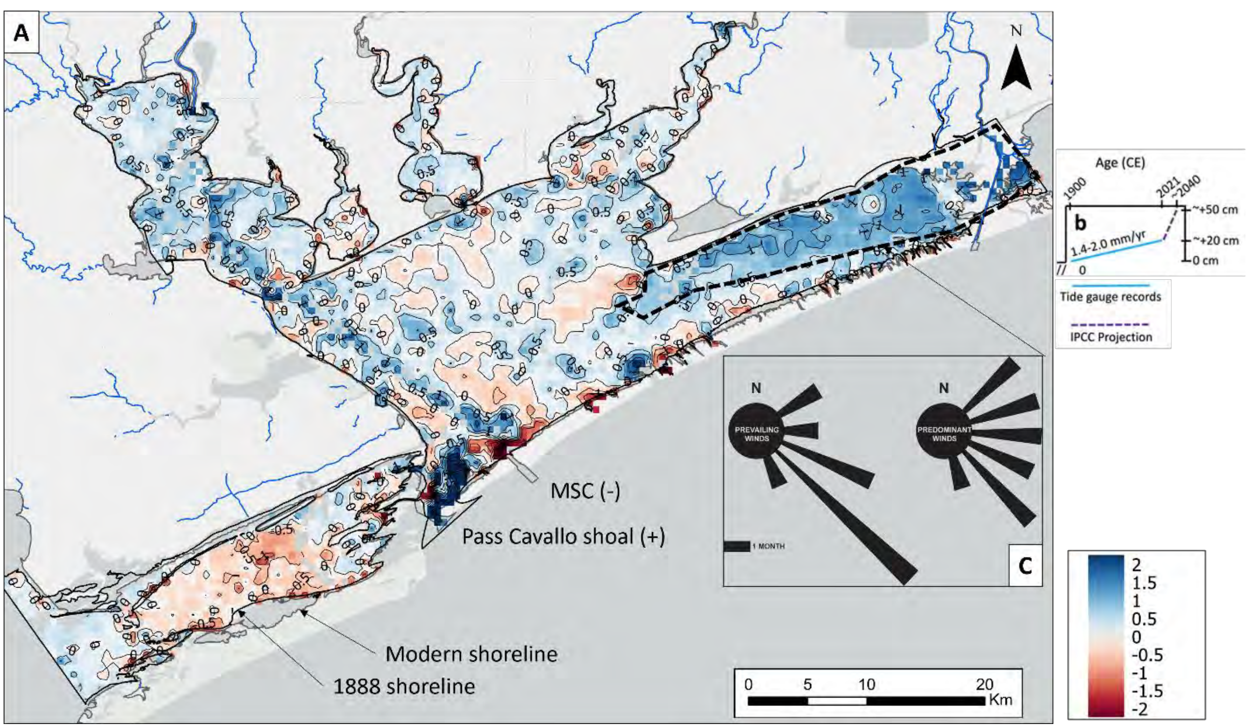

Figure 4. A) Historical bathymetric difference map constructed from 1888 and 2024 navigational charts, where blue and red (values are in meters) indicate areas that underwent deposition and erosion, respectively. B) Modern and projected sea level rise data, modified from Anderson et al., 2023. C) Prevailing and predominant wind directions, modified from McGowan 1979, used to explain the modern deposition of Colorado River sediments within downwind location (black polygon).

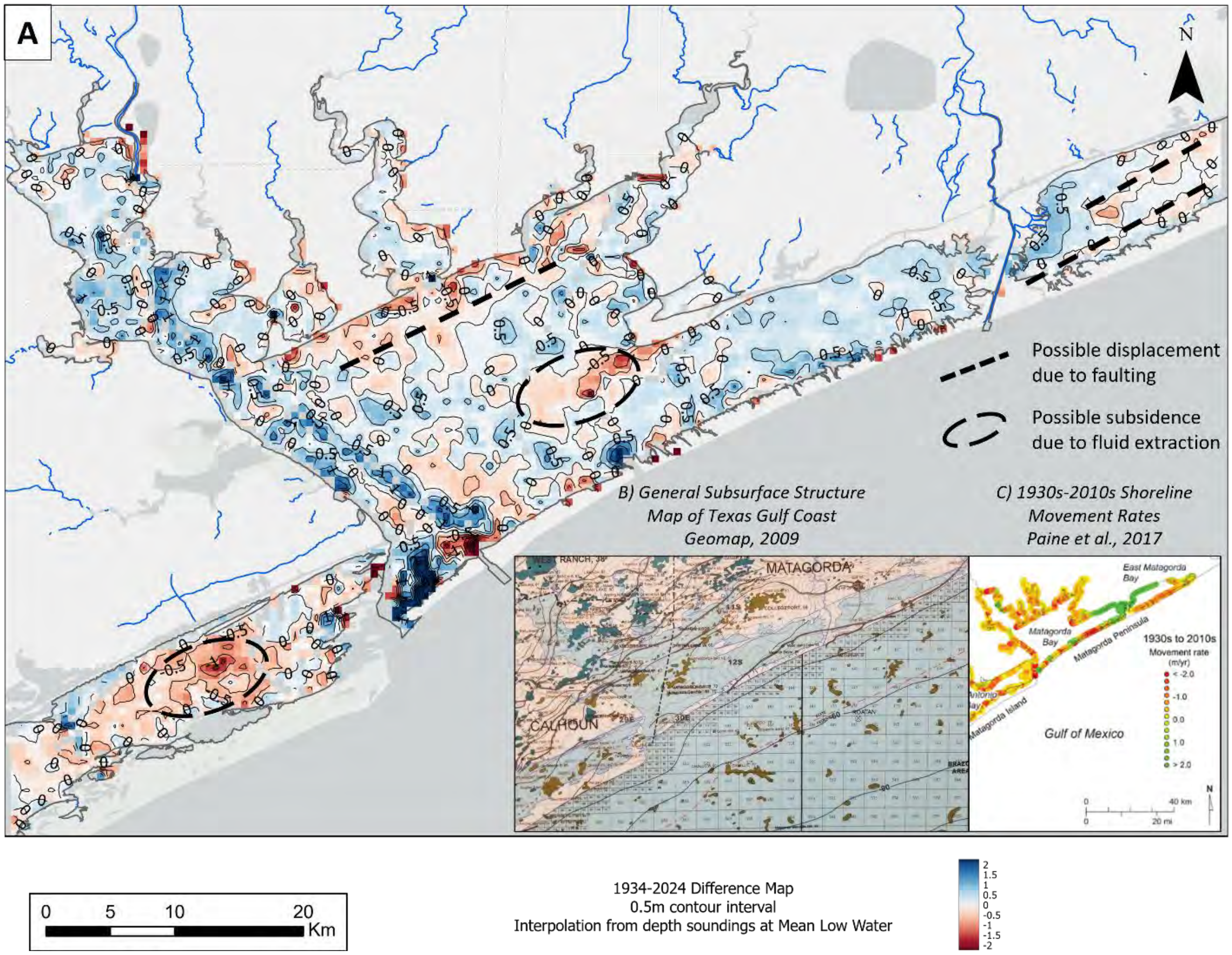

Figure 5. A) Historical bathymetric difference map constructed from 1934 and 2024 navigational charts, where blue and red indicate areas that underwent deposition and erosion, respectively. B) General structure map of Matagorda Bay, showing Cretaceous structures and oil and gas fields, which are hypothesized to be linked with bathymetric changes by active growth fault slip and subsidence related to fluid extraction. C) Historical shoreline movement from Paine et al., 2017, illustrating areas where recent storms penetrated the barrier and produced overwash deposits in the bay observed in the bathymetric difference map (i.e., at Greens Bayou).

The detection of microplastics using Pyrolysis-GC/MS was optimized and applied to plankton tow samples collected during the Fall 2023 field trip. Various purification methods were evaluated for isolating microplastics, with acid digestion proving to be the most effective for separating microplastics from biota-rich surface water samples. The isolated microplastics were subsequently analyzed via Pyrolysis-GC/MS, and the results were interpreted using F-Search MPs (Frontier Lab Ltd.), a comprehensive database of pyrolyzates and polymer libraries. This method identified six polymers in the surface water of Corpus Christi Bay: Polyvinyl chloride (PVC), Polymethyl methacrylate (PMMA), Polyethylene (PE), Polypropylene (PP), Nylon 66 (N66), and Styrene-butadiene rubber (SBR), with PVC and N66 being the most prominent, indicating the widespread presence of fibers in the bay system. We are currently establishing a standard calibration curve for 12 polymer standards to quantify the microplastics in the water samples. Once verified, this whole analysis method (**Figure 6**) will be applied to sediment samples to determine microplastic abundance in the Matagorda Bay system.

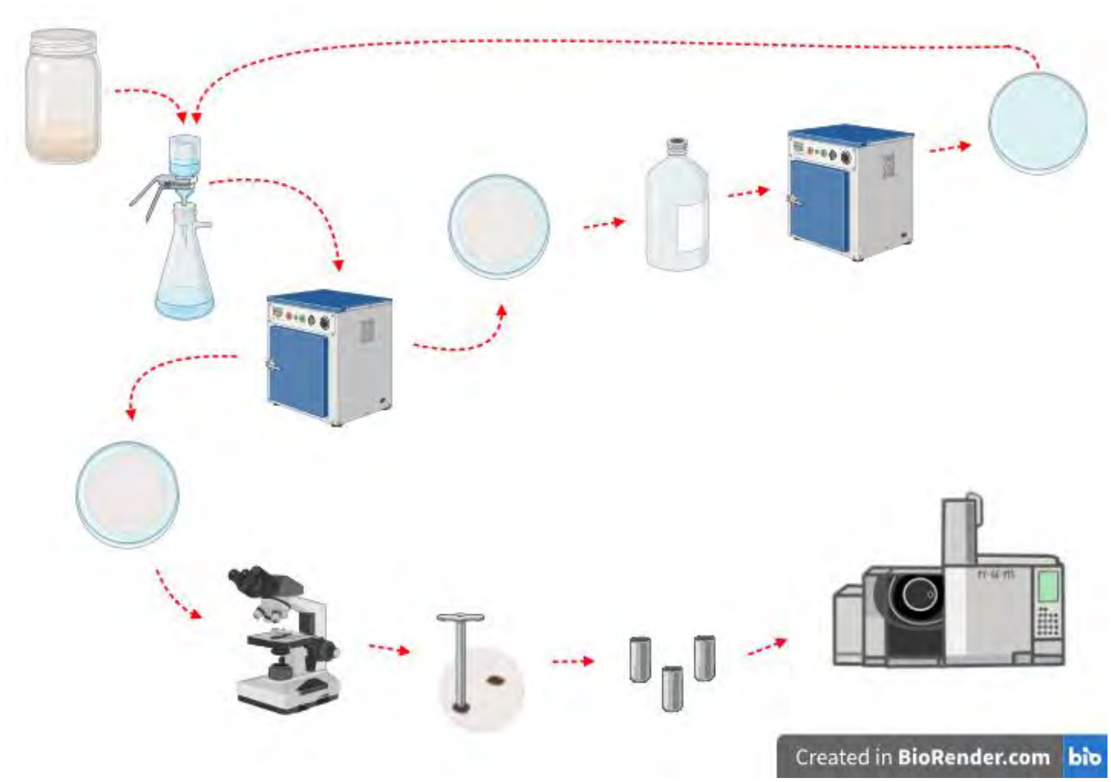

Figure 6. Graphical methods for environmental sample analysis.

References

Anderson, J. B., Wallace, D. J., Rodriguez, A. B., & Simms, A. R. (2023). Unprecedented Historical Erosion of US Gulf Coast: A Consequence of Accelerated Sea-Level Rise?. *Earth's Future*, *11*(9), e2023EF003676.

Feagin, R. A., Yeager, K. M., Brunner, C. A., & Paine, J. G. (2013). Active fault motion in a coastal wetland: Matagorda, Texas. *Geomorphology*, *199*, 150-159.

McGowen, J. H. (1979). Geochemistry of bottom sediments--Matagorda Bay system, Texas. *Virtual Landscapes of Texas*.