Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Evaluating Sediment Mobility on the Gulf of Mexico Outer Continental Shelf (OCS) (MM-23-01)
Administered by	Marine Minerals Program
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Procurement Type(s)	Inter-agency Agreement
Conducting Organization(s)	Naval Research Laboratory
Total BOEM Cost	TBD
Performance Period	FY 2023–2025
Final Report Due	TBD
Date Revised	April 14, 2022
PICOC Summary	
Problem	Incomplete understanding of sediment mobility across the OCS affects the ability of BOEM to adequately manage and preserve resources and provide effective environmental oversight. A comprehensive climatological analysis to evaluate the potential for seafloor sediment mobility across the Gulf of Mexico (GOM) OCS to the shelf break (200-m isobath) is needed to inform decisions on management and preservation of critical assets, such as infrastructure (i.e., pipelines, platforms) and cultural resources.
Intervention	Develop a regional modeling predictive tool that incorporates atmospheric (winds), hydrodynamic (ocean waves and currents), morphologic (bathymetry), and geologic (sediment type and distribution) parameters to characterize the probabilities of seafloor sediment mobility across the GOM OCS over the last 20 years
Comparison	A predictive tool in development at the NRL that currently estimates sediment mobility globally at the resolution of the Navy's operational wave and current (order 4 km), will be adapted to a regional higher resolution (order 1 km) wave and current model in the GOM. The GOM tool will additionally incorporate measured bathymetric and geological parameters (e.g., grain size distribution) to further refine its predictive skill. The tool will be used to compare probabilities of sediment mobility on the GOM OCS.
Outcome	A regional climatological analysis over the last 20 years of the seabed state across the GOM OCS that identifies regions and periods of high, moderate, and low sediment mobility probabilities. The analysis will primarily be used to inform management decisions on critical assets, particularly infrastructure and cultural resources, while also supporting planning needs across all three program areas.
Context	GOM OCS to the shelf break (200-m isobath). The seabed state predictive tool could be adapted for use in Atlantic and Pacific OCS Regions.

BOEM Information Need(s): BOEM needs to identify areas of increased sediment mobility to manage and preserve resources and provide effective environmental oversight. This comprehensive knowledge

will aid in the evaluation of the physical and environmental impacts to critical assets, such as existing infrastructure and cultural resources (e.g., displacement/damage of pipelines and platforms, shipwrecks and telecommunication cables, and pipeline leakage vulnerabilities); in the placement of future infrastructure, such as wind energy transmission lines and oil and gas pipelines; and dredging buffers around them, which sequester potential sediment resources. This information would also directly support infrastructure removal recommendations, particularly in vulnerable high-risk areas where sediment mobility can cause either exposure or excess burial of assets.

Background: While pipeline burial of 3 ft. (30 CFR 250 Subpart J) is required by the Bureau of Safety and Environmental Enforcement, pipeline exposure and displacement under extreme storm-driven or chronic sediment transport has been reported in various areas of the GOM OCS (personal communication with NOAA; Gearhart et al. 2011; Hooper and Suhayda 2005), indicating areas of increased sediment mobility may be widespread. That information is however anecdotal and not systematic. Several past and present BOEM-funded studies (e.g., BOEM 2016-038, GM-21-01, Harris et al. 2020) focused on understanding the factors that trigger sediment fluxes in the shelf during extreme events, such as during storms and hurricanes, and during high-energy gravity flow events in the Mississippi River Delta Front in the northern GOM. However, comprehensive knowledge of sediment mobility across the GOM OCS is still needed, particularly where and when dynamic seafloor areas may arise due to atmospheric, hydrodynamic, and geological factors. Evidence of increased sediment mobility and thus low seabed stability is of concern because it is unknown how these zones influence the structural integrity of surrounding infrastructure and resources. A strong storm event, for example, may alter an excavated dredge pit and thus potentially impact adjacent infrastructure and cultural resources if adequate buffers (Narin et al. 2005) are not in place that take into consideration the area being prone to sediment mobilization. Conversely, sediment resources otherwise unavailable within existing buffers may be freed for use in generally stable and less dynamic areas.

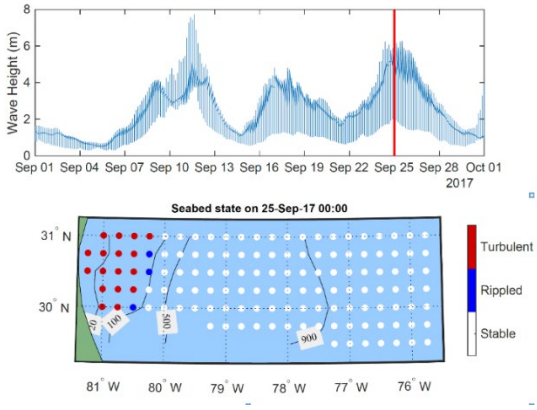

Figure 1: Top: WaveWatch III predicted significant wave heights for all locations in the Kings Bay, GA domain in 09/2017; Bottom: Preliminary output (wave-generated mobility only) from NRL's prototype seabed state predictive tool for 9/25/2017, showing regions of high (turbulent) and moderate to low (rippled) sediment mobility to the 100 m isobath, and no mobility (stable) offshore. Grid resolution is 4 km.

The U.S. Naval Research Laboratory at Stennis Space Center, MS, is currently developing a tool as part of an NRL Base Program funded project titled "Developing a shallow water environmental database for nearshore operations" that ingests reanalysis model data of globally simulated ocean waves and currents to predict the spatial and temporal mobilization of seafloor sediment over a given hindcasted time period. The tool currently assumes a homogeneous seabed composed of coarse quartz sand with a

single estimated median grain size (Figure 1). The development of algorithms that consider additional geological parameters (e.g., sediment type and distribution) as well as the ability to ingest higher resolution regional hydrodynamic data is necessary for developing a comprehensive and skilled analysis of the potential for seafloor sediment mobility in the GOM.

Objectives:

1. Set-up, run, and validate a regional (order 1-km resolution) GOM OCS coupled ocean hydrodynamic and seafloor sediment mobility simulation to hindcast temporal and spatial sediment mobilization in the GOM OCS over the last 20 years.
2. Generate and compare sediment mobility output from a simulation with a single grain size (median grain size quartz sand) in (1) to a simulation with spatially varying geologic parameters in a subset area domain (e.g., Louisiana).
3. Use model output to identify potential areas of increased sediment mobility on the GOM OCS.
4. Recommend best practices or strategy for management and preservation of resources around infrastructure and cultural resources based on seabed state and sediment mobility in the GOM.

Methods: Adapt NRL's seabed state predictive tool to function over regional scales (from 4 km to order 1-km grid resolution) using the Delft3D-Flexible Mesh hydrodynamic model in the GOM OCS (State Water line to the 200-m isobath). Perform a climatological analysis over the last 20 years to identify areas of high, moderate, and low sediment mobility probabilities in the GOM OCS. Characterize multi-scale physical processes (i.e., cyclic wave loading) and determine major modes of wind, circulation, and wave events at multiple (inter-annual, seasonal, synoptic) temporal scales that cause strong bottom shear episodes leading to sediment mobilization. Develop algorithms to allow incorporation of geological data into the model in the form of interpreted sediment type and distribution maps. Validate the model using NRL's repository of hydrodynamic and sediment observations in the GOM (Penko et al. 2017, Lim and Calantoni 2020). Ingest available sediment distribution maps for Louisiana (https://cims.coastal.louisiana.gov/Viewer/Map.aspx?guid=f8ec2690-bbb1-4879-ac30-aa44f5878b7f) into the model and assess effects of geological factors on sediment mobility at regional scales.

Specific Research Question(s):

1. What is the contribution of each of the primary atmospheric, hydrodynamic, morphological, and geological factors controlling sediment mobilization across the GOM OCS?
2. Where and during what conditions are regions of the GOM OCS at high, moderate, or low risk for sediment mobilization?
3. Which specific factors are most crucial for informing and improving future seafloor mobility assessments for identifying high-risk sediment instability areas at regional scales?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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