Environmental Studies Program: Ongoing Study

Study Area(s): Gulf of Mexico OCS

Administered By: Gulf of Mexico OCS Region

Title: Assessment of Mud-Capped Dredge Pit Evolution on the Outer Continental Shelf (OCS) of Northern Gulf of Mexico (NSL #GM-14-03-05)

BOEM Information Need(s) to be Addressed: Alterations to seafloor topography from dredging OCS sediment resources have the potential to affect oil and gas infrastructure, other resources of concern located proximal to dredge pits, and fish habitat. Direct impacts from dredging are well understood and mitigated for through the Bureau of Ocean Energy Management's (BOEM's) environmental review and coordination throughout the sand leasing process. However, understanding of long-term borrow area geomorphic evolution is poor; especially for some recent cases in the Gulf of Mexico where targeted sand resource deposits underlie muddy overburden resulting in relatively deep pits with a "muddy cap" (pit walls are characterized by cohesive muds overlying unconsolidated sands). While dredge pit evolution is expected (*e.g.*, expansion of pit beyond extent of dredging activity) and mitigations are applied to protect adjacent areas, the basis for assigning buffer distances is somewhat objective and effectiveness of mitigations has not been evaluated. BOEM has devoted funding toward better understanding how mud-capped pits evolve and potential impacts to infrastructure and/or resources of concern located adjacent to the pit (Narin *et al.* 2005; 2007). However, site-specific data required to make accurate predictions and empirical measurements to test and validate predictive models were only available for one of the sites studied. This study will build on BOEM's investment toward better understanding this problem by filling data gaps identified in and refining predictive models developed during previous studies. It will also evaluate the effectiveness of mitigations applied to existing dredge pits (*e.g.*, setback distances from pipelines, post excavation monitoring, *etc.*) to determine if resources and infrastructure are being protected. Results will increase BOEM's decision making ability regarding safety and protecting environmental and cultural resources and provide for better management of valuable OCS sand resources.

Total BOEM Cost: $357,099 **Period of Performance:** FY 2014–2018
Total non-Federal Contributions (LSU): $357,382

Conducting Organization(s): Louisiana State University (LSU), BOEM

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Description:
Background: Much of the northern Gulf of Mexico shelf is characterized by a

dominantly muddy seafloor with a paucity of restoration-quality sand close to shore. Large sand shoals occur on the shelf but their distance from shore has been cost prohibitive for most restoration projects. However, discrete sand deposits associated with ancient rivers that flowed across the shelf during lower sea-level positions occur closer to shore on the OCS. The channels were filled with sandy sediments as sea-level rose and ultimately buried by recent shelf mud deposition. These shelf channel sands are used for coastal restoration projects resulting in significant cost savings over more distal deposits. These savings ultimately benefit the project's effectiveness and sustainability since greater quantities of sand can be placed for lower cost. Sand deposits in these cases often underlie a muddy overburden so a relatively deep dredge pit is produced with walls composed of cohesive muds overlying sands. The evolution of these "mud capped" pits is not well understood relative to the more common sand-only borrow areas.

Numerical models have been developed to predict how BOEM-authorized OCS mud-capped dredge pits evolve in response to physical forcings including hydrodynamics, sediment dynamics, and local pit wall/seafloor stability (Nairn *et al.* 2004; 2005). Model development was primarily based on empirical measurements at the Peveto Channel (PC) dredge pit offshore Holly Beach, Louisiana. After model validation with real-world measurements (*e.g.*, time series of bathymetric surveys capturing dredge pit geometry and evolution), the models were employed to predict pit evolution at the Sandy Point Southeast (SPSE) proposed dredge pit. SPSE has similar stratigraphy to PC (both were relict channel fill sands with muddy overburden) and was utilized for construction of the Pelican Island (Louisiana) Restoration Project. Unlike the PC site, no site-specific empirical data were available as input for SPSE model predictions, and the hydrodynamics and geology differ from PC because of SPSE's location in the Barataria Bight where the modern Mississippi river delta results in a complex wave climate and current circulation patterns, and proximity to the river provides increased sediment supply. Dredging at SPSE was completed in November 2012 and post-dredging bathymetric survey data indicate that within the first month, there was rapid initial adjustment of some pit walls where topographic changes have occurred extending up to 100 m beyond the dredge template. It is hypothesized that this initial adjustment reflects local mass wasting (collapse or slump) of upper cohesive deposits comprising pit walls into the pit and that this initial response to the temporary disequilibrium conditions introduced by dredging will not continue at this rapid rate as pit infilling occurs (supplied by suspended sediment from the Mississippi River plume and erosion of the adjacent shelf muds) and side slopes stabilize. A third pit was recently excavated in 2013 offshore Raccoon Island (RI), Louisiana for the Raccoon Island Backbarrier Marsh Restoration Project. RI targeted paleo-channel muddy sands with no overburden but produced a pit similar to the PC configuration. The location of the RI pit is landward of the Ship Shoal sand body in a unique setting where it has been shown that the shoal heavily influences local hydrodynamics and attendant sediment dynamics. These newly excavated pits provide an opportunity to test model predictions and effectiveness of assigned mitigations, monitor pit geomorphic evolution, develop monitoring protocols, and refine predicative capability for future projects to inform environmental consultations.

Louisiana Coastal Protection and Restoration Authority has recently implemented their Borrow Area Managing and Monitoring (BAMM) program that is monitoring physical changes and water quality at borrow areas within state waters. This proposed effort would complement BAMM and other programs focused on long term sediment management for and understanding impacts of mining sediment for coastal restoration in Louisiana.

Objectives: This study will:

- quantify and greatly enhance our understanding of mud-capped dredge pit evolution through development of a geomorphic evolutionary model
- refine and validate predictive numerical model for dredge pit evolution
- assess effectiveness of existing mitigations
- provide recommendations for pit monitoring protocols and suggested mitigations based on empirical measurements and refined numerical model.

Methods: This study focuses on three mud-capped OCS dredge pits in the Gulf of Mexico, PC, RI, and SPSE. PC was excavated in 2002 and site specific data were collected to study the evolution of that pit over a period of 2 years following excavation and models predicting pit evolution were developed. New swath bathymetric and side-scan sonar, subbottom profiler, sedimentologic (vibracores), bottom boundary layer sediment dynamics, and physical oceanographic data were be collected at PC to assess present pit morphology and assess accuracy of model predictions. Similar suites of data were collected at SPSE and RI. Additionally, physical oceanographic parameters (*e.g.* waves, currents, suspended sediment concentration, *etc.*) were measured seasonally and complimentary time-series (seasonal to semi-annual) bathymetric datasets were collected at SPSE and RI to track pit evolution over a 2 year field effort. Effectiveness of assigned setback buffers will be assessed over the short term based on observational data.

Existing and newly acquired observational data will be analyzed and employed to refine existing numerical models for pit evolution and potentially develop more sophisticated numerical and/or statistical models with the goal of developing a tool that can be used to better evaluate proposed dredge pit scenarios. Once developed, the model(s) will also be applied to predict pit evolution over the long term and determine if further mitigation or monitoring is necessary.

Based on findings from conceptual and numerical/statistical model development of dredge pit morphologic and sedimentologic evolution, a monitoring protocol to track pit evolution will be developed and potential mitigations on future muddy capped pits will be suggested.

References

Nairn, R.B., Langendyk, S.K., and Michel, J., 2004, Preliminary Infrastructure Stability Study, Offshore Louisiana: U.S. Department of Interior, Minerals Management Service, Gulf of Mexico Region, New Orleans, LA, OCS Study, MMS 2005-043, 179 p. with appendices.

Nairn, R.B., Lu, Q., Langendyk, S.K., and Michel, J., 2005, A study to Address the Issue of Seafloor Stability and the Impact on Oil and Gas Infrastructure in the Gulf of Mexico: U.S. Department of Interior, Minerals Management Service, Gulf of Mexico Region, New Orleans, LA, OCS Study, MMS 2005-043, 179 p. with appendices.

Nairn, R.B., Lu, Q., Langendyk, S.K., Hayes, M.O., Montagna, P.A., Palmer, T.A., and Powers, S.P., 2007, Examination of the Physical and Biological Implications of Using Buried Channel Deposits and other Non-Topographic Offshore Features as Beach Nourishment Material: U.S. Department of Interior, Minerals Management Service, Gulf of Mexico Region, New Orleans, LA, OCS Study MMS 2007-048, 231 p. with appendices.

Current Status: LSU submitted draft final report to BOEM. BOEM provided comments back to LSU for submission of final report.

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Publications Completed: N/A

Affiliated WWW Sites: N/A

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