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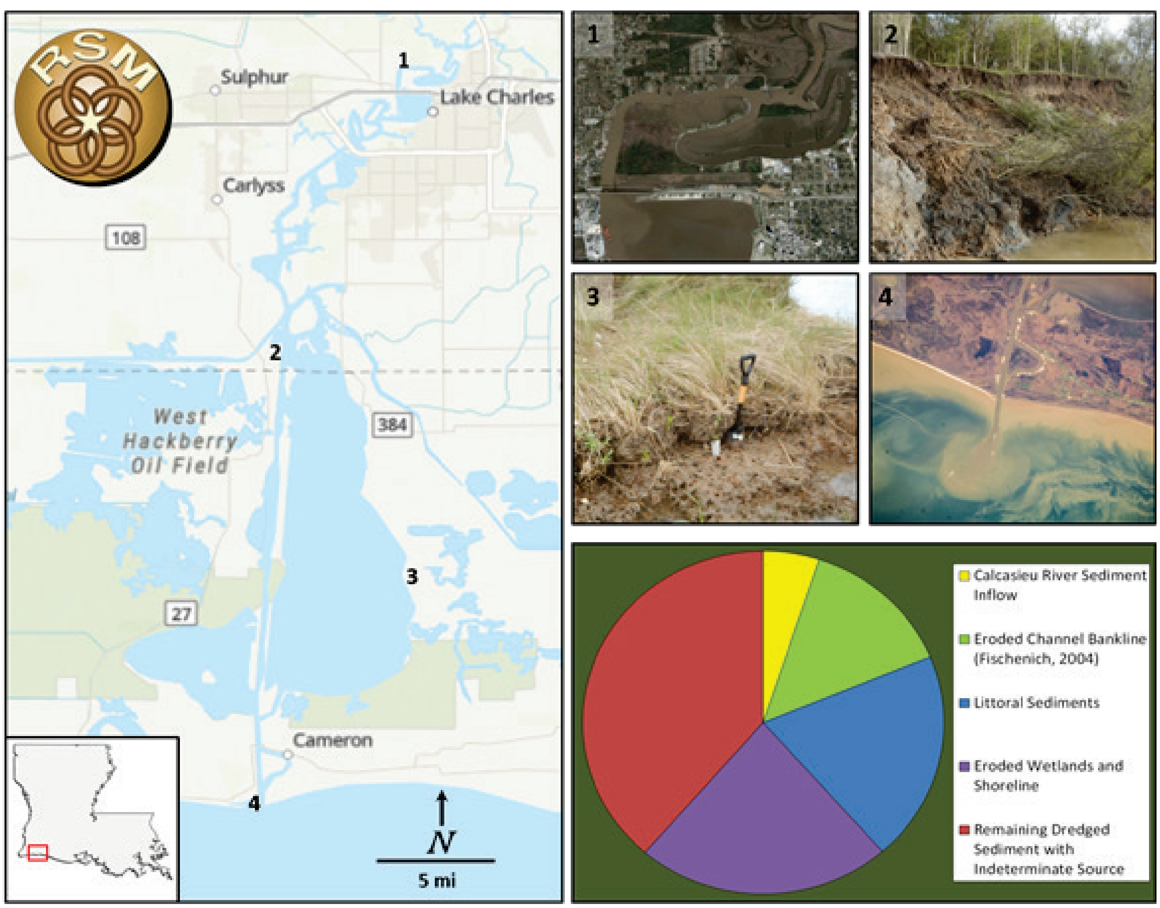
Regional Sediment Management Program

Investigation of Sources of Sediment Associated with Deposition in the Calcasieu Ship Channel

Gary L. Brown and Phu V. Luong

July 2022



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Final report

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Abstract

The Calcasieu Ship Channel (CSC) is a deep-draft federal channel located in southwest Louisiana. It is the channelized lowermost segment of the Calcasieu River, connecting Lake Charles to the Gulf of Mexico. With support from the Regional Sediment Management Program, the US Army Corps of Engineers, New Orleans District, requested that the US Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory, perform an investigation of the potential sources of sediment associated with dredging in the CSC. A previous study had quantified sediment from known sources, indicating that the known sediment sources contribute approximately only 21% of the volume that is regularly dredged from the channel. This technical report details the results of the current study, which employed multiple methods, including numerical analysis, to identify potential additional sources of sediment by first examining the available literature and the modeled energetics and flow pathways, and then estimating the quantities of sediment associated with these identified sources that may be contributing to the shoaling of the CSC. The results of these efforts were used to update the original sediment budget with estimates of the contributions from two additional sources: the erosion of interior wetlands and coastally derived sediments.

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Preface

This study was conducted for the Regional Sediment Management (RSM) Program under Funding Account Code U4375439; AMSCO Code 008303. The technical monitor was Dr. Katherine E. Brutsché.

The work was performed by the River Engineering and Estuarine Branch of the Flood and Storm Protection Division, US Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory (ERDC-CHL). At the time of publication of this report, Mr. David P. May was chief, River Engineering and Estuarine Branch; Dr. Cary A. Talbot was chief, Flood and Storm Protection Division*;* and Mr. Charles E. Wiggins, was the technical director for Navigation. The deputy director of ERDC-CHL was Mr. Keith W. Flowers, and the director was Dr. Ty V. Wamsley.

The commander of ERDC was COL Christian Patterson, and the director was Dr. David W. Pittman.

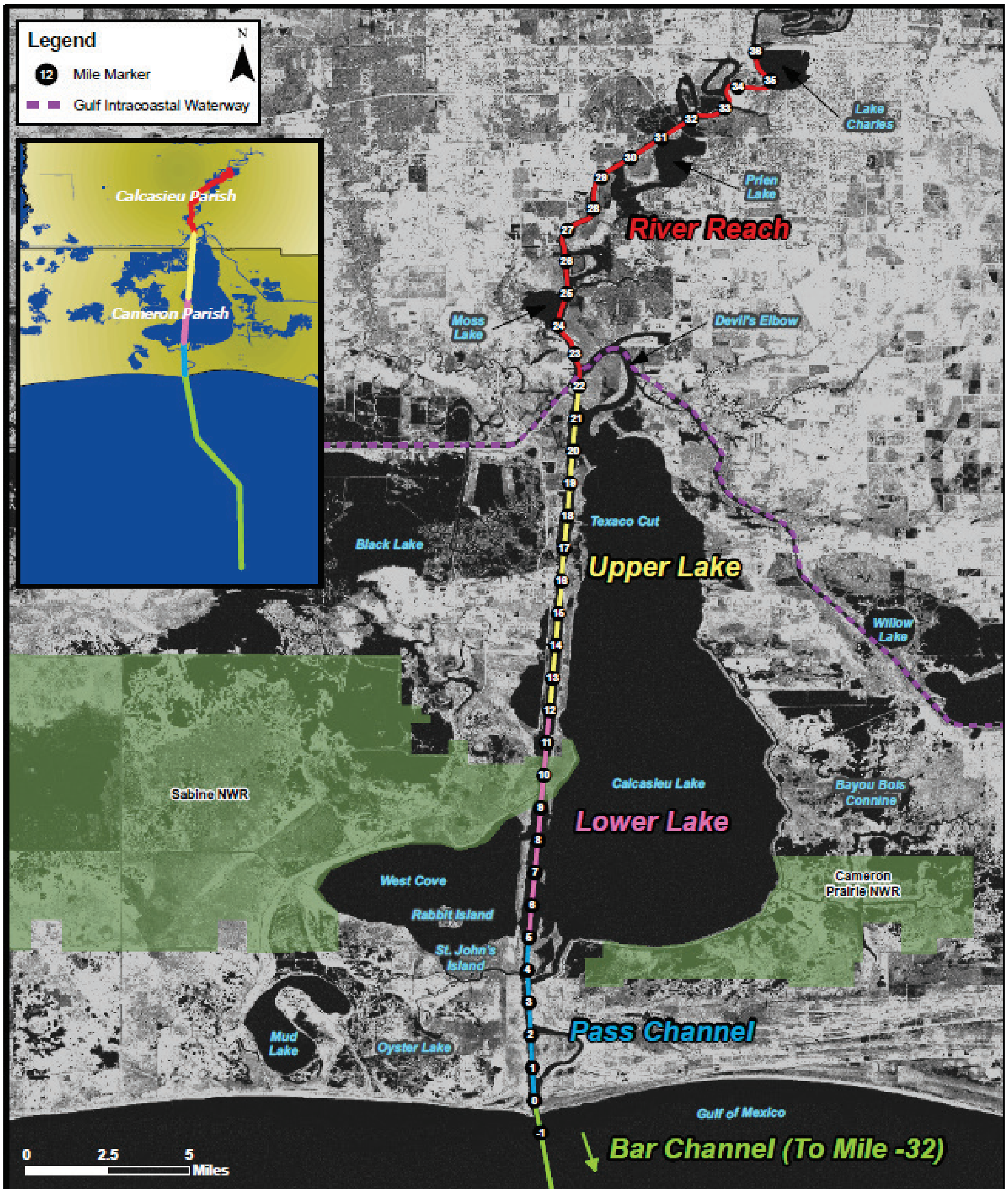
1 Introduction

1.1 Background

The Calcasieu Ship Channel (CSC) is a deep-draft federal channel located in southwest Louisiana. It is the channelized lowermost segment of the Calcasieu River, connecting Lake Charles to the Gulf of Mexico (Figure 1). In 2003, the US Army Corps of Engineers, New Orleans District (MVN), sponsored a study of the project to determine the extent to which erosion of the banklines and of Confined Disposal Facilities (CDFs) adjacent to the channel contribute to the shoaling. The study was conducted by personal in the Environmental Laboratory at the US Army Engineer Research and Development Center (ERDC). The study found that the combined contributions of the CDFs bankline erosion and the sediment inflow from the Calcasieu River could account for approximately 21% of the total volume of sediment dredged annually between River Mile (RM) 5 and 36 of the CSC[1]. Therefore, to understand and potentially mitigate for channel sediment deposition, it is necessary to identify and quantify the source or sources of the remaining 79% of sediment that is deposited in the CSC.

[1] Fischenich, Craig G. 2004. Unpublished Draft. *Calcasieu River and Ship Channel Erosion and Sediment Impact Assessment (Phase 1)*. DRAFT report prepared for the US Army Corps of Engineers, New Orleans District. Vicksburg, MS: US Army Engineer Research and Development Center.

Figure 1. Wide view of the study area with labeled features of interest (Gahagan and Bryant Associates [2009]).



1.2 Objective

With support from the Regional Sediment Management Program, the MVN requested that the ERDC Coastal and Hydraulics Laboratory perform an investigation of the potential sources of sediment associated with dredging in the CSC. Previous studies have quantified sediment from known sources, but these studies have shown that these known sources contribute only approximately 21% of the volume that is regularly dredged from the channel. The current study employed multiple methods to identify additional potential sources of sediment that may be contributing to the shoaling of the CSC.

1.3 Approach

The approach taken for this study, and documented in this report, has been to investigate these potential sources of sediment using multiple means of investigation. The approach is outlined as follows:

- Revisit the original sediment budget of Fischenich[1] to confirm the findings.
- Review available literature to hypothesize potential additional sources of sediment.
- Employ numerical modeling to investigate the potential transport pathways for these sources, and to quantify (approximately) their relative contributions to the sediment budget

The results of these analyses are provided in the following sections of this report.

[1] Fischenich, Craig G. 2004. Unpublished Draft. *Calcasieu River and Ship Channel Erosion and Sediment Impact Assessment (Phase 1)*. DRAFT report prepared for the US Army Corps of Engineers, New Orleans District. Vicksburg, MS: US Army Engineer Research and Development Center.

2 Existing Sediment Budget

The sediment budget of Fischenich[1] was revisited, and a summary of this sediment budget is provided in this section.

When computing a sediment budget, one must account for the fact that sediment flux is typically expressed in terms of sediment mass (or concentration) whereas deposited sediment is typically expressed in terms of sediment volume. The most straightforward way to account for these differences is to express the budget in terms of sediment mass, by multiplying each source of deposited sediment volume by the dry bulk density associated with each deposit. However, dredging quantities are typically expressed in terms of sediment volume. Therefore, for this sediment budget, it is convenient to express all the sediment quantities associated with the sediment budget in terms of sediment volume.

To do this, one must first select a characteristic dry bulk density for the sediment and then express all of the terms in the sediment budget in terms of the volume of sediment as determined by this bulk density. For this sediment budget, a dry bulk density was selected that was consistent with the measured values of the dry bulk density of sediment deposited in the Calcasieu Channel (Environmental Laboratory 2005). The value selected was 530 kg/m^3.[2,3] The sediment associated with Calcasieu River inflow was converted to this volume, and the sediment associated with erosion of the channel banks[1] was converted from the assumed in situ dry bulk density of 1,855 kg/m^3 for this value.

US Geological Survey (USGS) observations of the sediment load from the Calcasieu River at Kinder, LA, were checked against the rating curve used by Fischenich[1] and found to be consistent. This rating curve was then

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[1] Fischenich, Craig G. 2004. Unpublished Draft. *Calcasieu River and Ship Channel Erosion and Sediment Impact Assessment (Phase 1)*. DRAFT report prepared for the US Army Corps of Engineers, New Orleans District. Vicksburg, MS: US Army Engineer Research and Development Center.

[2] For a full list of the spelled-out forms of the units of measure used in this document, please refer to *US Government Publishing Office Style Manual*, 31st ed. (Washington, DC: US Government Publishing Office 2016), 248-52, https://www.govinfo.gov/content/pkg/GPO-STYLEMANUAL-2016/pdf/GPO-STYLEMANUAL-2016.pdf.

[3] For a full list of the unit conversions used in this document, please refer to *US Government Publishing Office Style Manual*, 31st ed. (Washington, DC: US Government Publishing Office 2016), 345-7, https://www.govinfo.gov/content/pkg/GPO-STYLEMANUAL-2016/pdf/GPO-STYLEMANUAL-2016.pdf.

integrated against USGS river discharge measurements at Kinder for the time period 1996 through 2016 to generate an estimate of the annual load. Assuming a deposited dry bulk density of 530 kg/m^3, this annual load is estimated at 259,000 yd^3/yr.

Using the estimated values of bankline erosion given by Fischenich[1] and converting this volume to the volume associated with channel deposition using the dry bulk density of 530 kg/m^3, the estimated contribution of bankline erosion to the sediment budget is 694,000 yd^3/yr.

Utilizing dredging records provided by the MVN, the average annual rate of sediment dredging in the CSC between RMs 5 and 36 for the time period 1996 through 2016 was computed to be 4,811,000 yd^3/yr, with a standard deviation of 3,561,000 yd^3/yr. This rate of dredging is consistent with rates of dredging reported by other studies (e.g., 4,836,000 yd^3/yr, in Gahagan and Bryant Associates [2009]).

Using these quantities, the initial sediment budget can be computed by subtracting the known sediment inputs (the Calcasieu River inflow and the bankline erosion) from the average annual dredging quantities. The resulting sediment budget is given in Figure 2.

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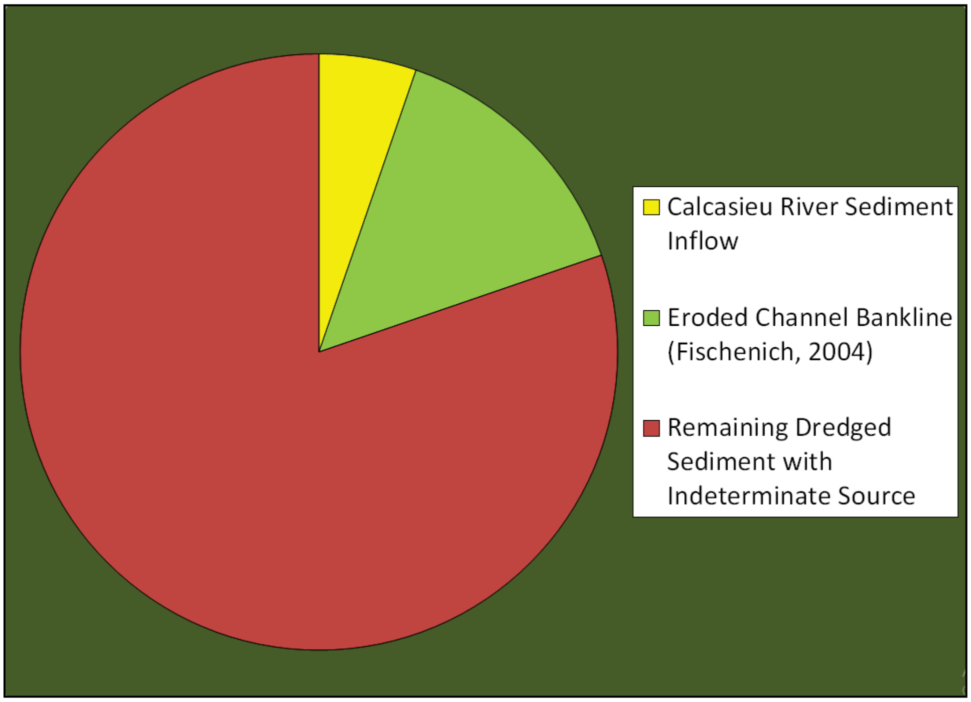
[1] Fischenich, Craig G. 2004. Unpublished Draft. *Calcasieu River and Ship Channel Erosion and Sediment Impact Assessment (Phase 1)*. DRAFT report prepared for the US Army Corps of Engineers, New Orleans District. Vicksburg, MS: US Army Engineer Research and Development Center.

Figure 2. The initial sediment budget.



Note that this sediment budget accounts for approximately only 20% of the sediment that is dredged from the channel. The other 80% is derived from other sources not yet identified. The remainder of this report addresses the unidentified sources.

Note also that this sediment budget is consistent with the budget generated in Fischenich[1]. Also, note that an implicit assumption of this sediment budget is that all the sediment that enters the Calcasieu Lake system eventually deposits in the channel; that is, there is no significant net deposition elsewhere in the system.

[1] Fischenich, Craig G. 2004. Unpublished Draft. *Calcasieu River and Ship Channel Erosion and Sediment Impact Assessment (Phase 1)*. DRAFT report prepared for the US Army Corps of Engineers, New Orleans District. Vicksburg, MS: US Army Engineer Research and Development Center.

3 Literature Review: Potential Additional Sources of Sediment

A review of the available literature reveals two principal candidates for the sources of some, or most, of the sediment that is unaccounted for in the initial sediment budget, as well as some other potential sources.

3.1 Littoral (offshore) sediment

The Mississippi River and Atchafalaya River discharge significant quantities of fine (silt and clay)-sized sediment into the littoral system. Kolker et al. (2014) measured suspended sediment concentrations of 20 to 390 ppm on the Atchafalaya River shelf. These coastal sediments are transported along the shoreline, with the net littoral drift being directed westward along the shore (Georgiou et al. 2016). There are also observations of significant shoreline erosion, which contributes both fines and sands to the littoral transport (Georgiou et al. 2016). Some portions of these sediments are entrained by flood-tidal currents and/or baroclinic circulation into Calcasieu Lake via the CSC. Evidence of this can be observed inside the lake, where coastally sourced sands and marine shell fragments can be found in the lowermost regions of the lake (Zhang et al. 2013).

3.2 Coastal wetland loss

The Chenier plain wetlands have experienced significant losses in recent decades. These have been attributed to two primary causes: (1) dredging of the Calcasieu and Sabine-Neches deep-draft channels, which resulted in salinity intrusion into the historically fresh marshes of this region, and subsequent erosion of the marshes via storm induced flooding and wave action, and (2) local accelerated subsidence associated with the development of oil and gas extraction wells ("The Calcasieu-Sabine Basin" https://www.lacoast.gov/new/Default.aspx [Bernier et al. 2011]). The USGS estimates that although rates of wetland loss in the Calcasieu-Sabine system have slowed in recent decades, the rate of loss is still on the order of 3 km^2/yr. (Couvillion et al. 2017) Assuming a range of marsh dry bulk density between 110 and 390 kg/m^3 (Cahoon and Turner 1989) and assuming (grossly) an average of 1 ft of marsh thickness is eroded, this rate of loss represents a potential source of channel deposition on the order of 500,000 to 1,800,000 yd^3/yr. This order of magnitude calculation demonstrates that interior marsh erosion is potentially a significant source of sediment deposition in the CSC.

3.3 Other sources of sediment

Other potentially significant sources of sediment include (1) the erosion of the Calcasieu Lake and Gulf Intracoastal Waterway (GIWW) shorelines[1], (2) sediment originating from the Sabine River and delivered to the Calcasieu system via the GIWW[2], and (3) fluid mud that forms in the bar channel offshore and is (potentially) transported inshore by tidal pumping and net/or inland residual circulation associated with salt wedge intrusion (Lin et al. 2016).

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[1] Fischenich, Craig G. 2004. Unpublished Draft. *Calcasieu River and Ship Channel Erosion and Sediment Impact Assessment (Phase 1)*. DRAFT report prepared for the US Army Corps of Engineers, New Orleans District. Vicksburg, MS: US Army Engineer Research and Development Center.

[2] Brown, G. L., M. S. Sarruff, R. Vemulakonda, G. H. Nail, J. Stokes, and B. Mann. 2009. Unpublished draft report. *Numerical Model Study of Potential Salinity Impacts Due to Proposed Navigation Improvements to the Sabine-Neches Waterway, TX*. Draft report.

4 Numerical Modeling

To investigate the mechanisms whereby these various sources could potentially deliver sediment to the CSC, and to approximate the potential magnitudes of their contribution, a numerical model was developed, and some numerical experiments were conducted. The following section details this effort.

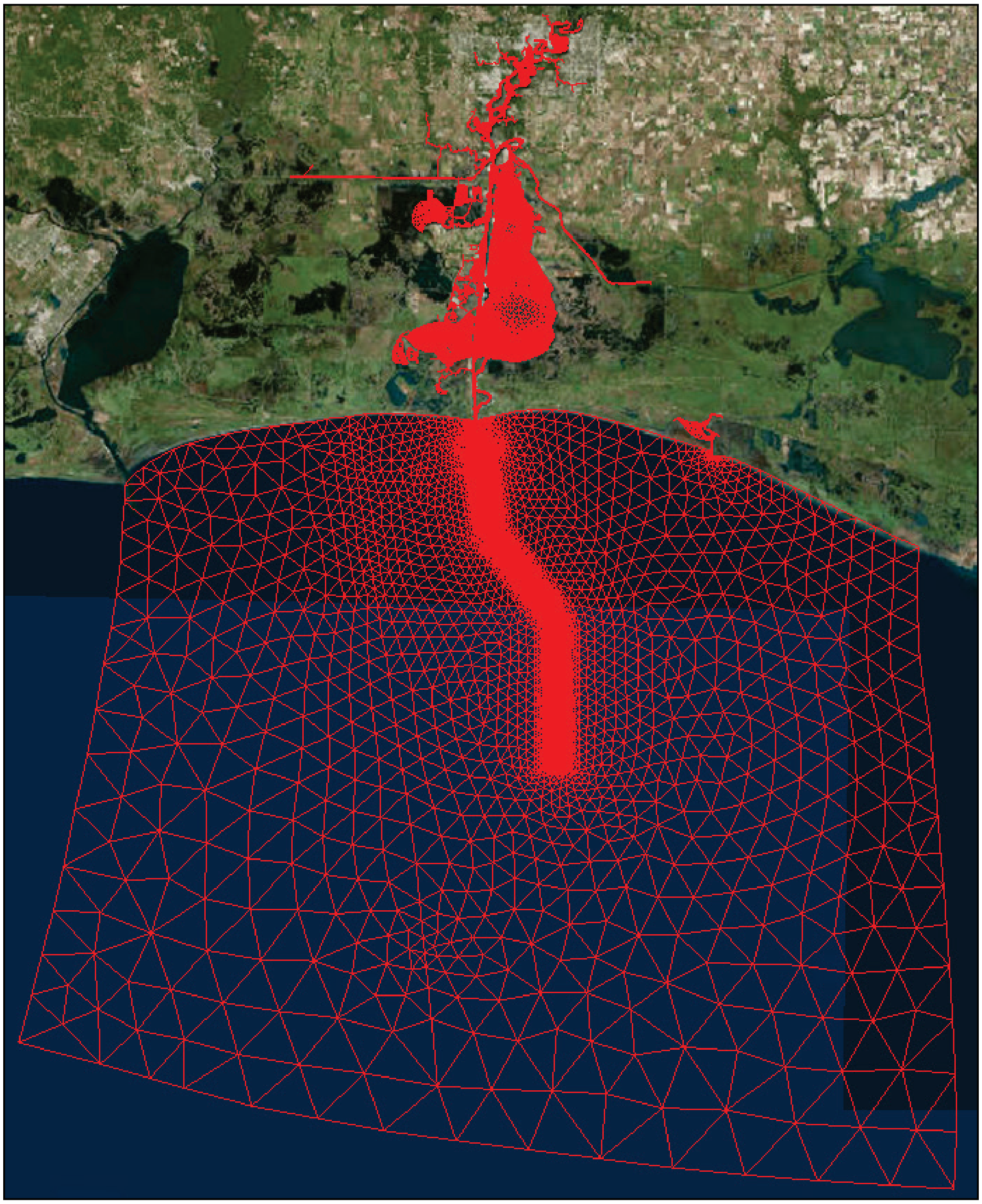
4.1 Numerical model description

The Adaptive Hydraulics (AdH) Model, coupled with the SEDLIB sediment transport library, was used for this study. AdH is a finite element model that can simulate three-dimensional Navier-Stokes equations, two- and three-dimensional shallow water equations, and groundwater equations. (Tate et al. 2006). For this study, the two-dimensional shallow water module of AdH was utilized with linkage to the sediment library, SEDLIB. SEDLIB is a sediment transport library developed at ERDC. (Brown 2012a,b). It can solve problems consisting of multiple grain sizes, cohesive and cohesionless sediment types, and multiple layers. It calculates erosion and deposition processes simultaneously and simulates such bed processes as armoring, consolidation, and discrete depositional strata evolution. (More details of the two-dimensional shallow water module of AdH and SEDLIB can be found at https://chl.erdc.dren.mil/chladh.)

The model application used for this study was adapted from an existing model that was developed for the MVN to address a separate issue within the same system, associated with the Calcasieu Lock[1]. The model mesh, bathymetry, and applied boundary conditions were adapted from this study. The model mesh used for the current study is shown in Figure 3. The model includes all of Calcasieu Lake and the Calcasieu River up to the Saltwater Barrier. It extends east and west of the system for some distance along the GIWW and extends south to include all the bar channel. The mesh includes 169,429 elements and 98,149 nodes.

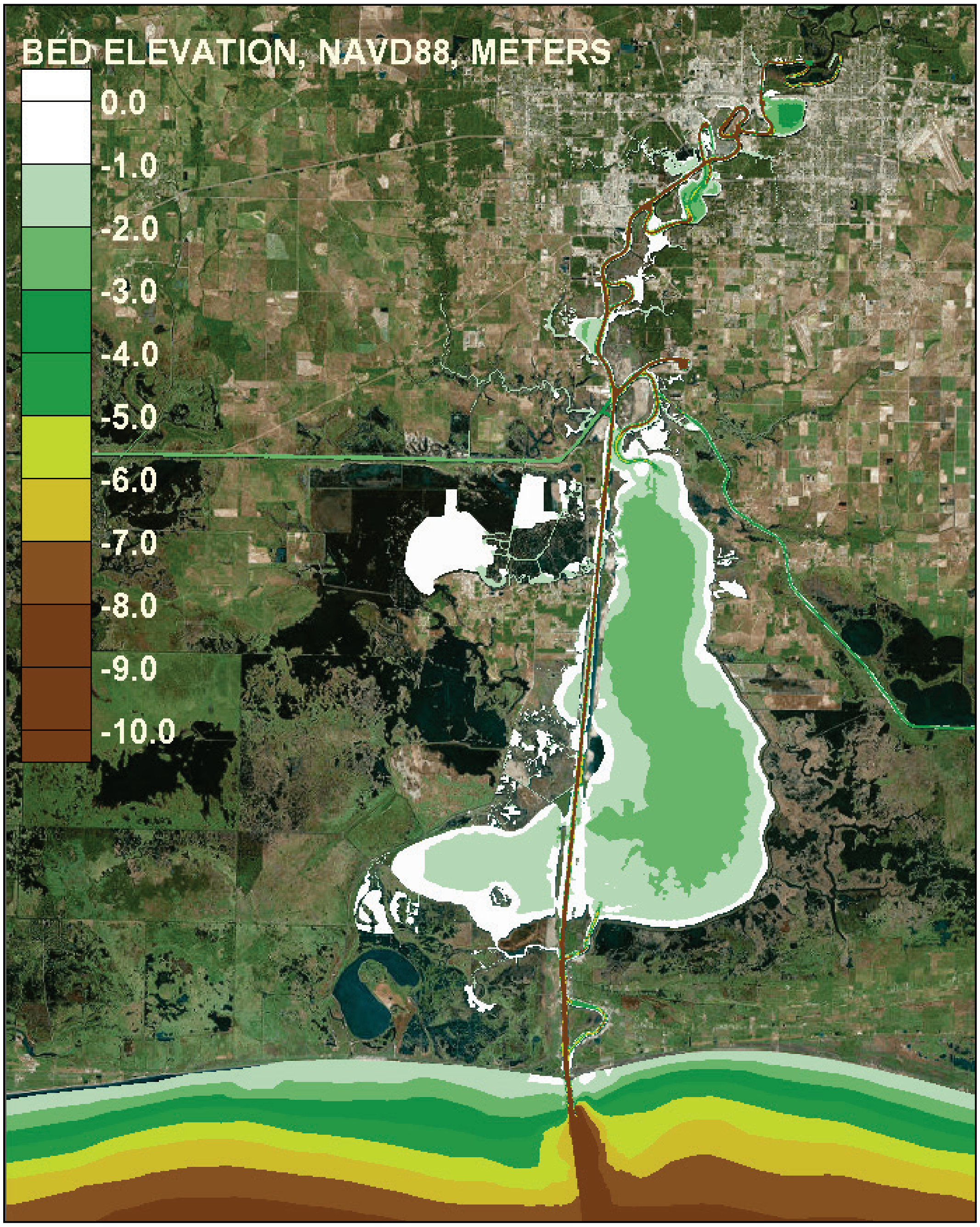
[1] McKnight, C. Jared, Tate O. McAlpin, and Joseph V. Letter, Jr. 2017. Unpublished draft report. *Calcasieu Lock and Drainage Study: Numerical Modeling of Hydrodynamics*. US Army Engineer Research and Development Center Draft report prepared for the US Army Corps of Engineers, New Orleans District.

Figure 3. The AdH model mesh used for this study.



The model bathymetry is shown in Figure 4. The model bathymetry was taken from an ADCIRC storm surge modeling effort (Dietrich et al. 2008) and supplemented with multi-beam bathymetric data collected in all the channels of significance by MVN.

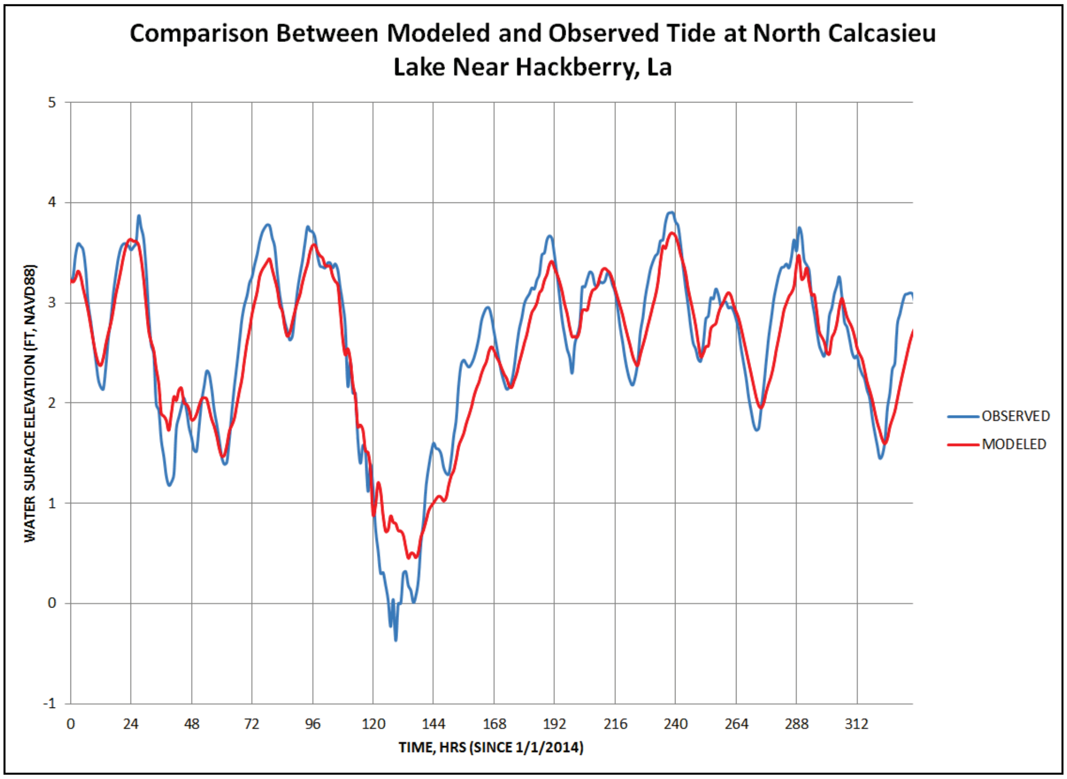
Figure 4. The model bathymetry.



The model hydrodynamic boundary conditions consisted of Calcasieu River inflows (taken from the USGS station at Kinder, LA, USGS 08015500), applied winds (as observed at Calcasieu Pass CO-OPS 8768094), and offshore tidal variation (generated synthetically from observed tidal constituents and sub-tidal variation). The model simulations were conducted from January through December of 2014.

Since the modeling effort conducted for this study was only qualitative in nature, and since there were limited hydrodynamic data available for model comparisons, the only model validation that was undertaken was a single comparison between the modeled and observed tide in North Calcasieu Lake near Hackberry, LA (USGS 08017095). The comparison plot is given in Figure 5.

Figure 5. Comparison between modeled and observed tide at North Calcasieu Lake near Hackberry, LA, for 1/12014 through 1/14/2014.



4.2 Numerical model simulation parameters

The objectives of the modeling effort for this study were as follows:

- Investigate the transport mechanisms and pathways within the Calcasieu Lake system.
- Determine the potential for sediment introduced from both the Calcasieu River and from offshore (littoral) transport to enter Calcasieu Lake and be (ultimately) deposited in the CSC.
- Estimate the amount of sediment entrained into the Calcasieu Lake system from offshore (littoral) sources.

To accomplish these goals, the model was simulated for the following conditions:

- A westerly coastal current of approximately 0.1 m/s was imposed on the offshore boundary, to approximate the littoral current.
- Five fine sediment size classes (ranging from clay to coarse silt) were introduced both as inflow at the Calcasieu River salinity control structure, and separately into the littoral drift.
- The sediment at the Calcasieu Inflow was determined by the sediment rating curve given in Fischenich[1].
- For the sediment associated with the littoral drift, a range of total suspended solids concentrations between 25 and 75 ppm were simulated.
- Equal fractions of each sediment class were applied at each boundary (i.e., each class constituted 20% of the sediment supply).
- Since this was a depositional study, no initial sediment bed was provided (i.e., the model cannot erode any sediment that does not originate from one of the model boundaries).
- The model was simulated from January through December of 2014.

The settling, erosional, and depositional properties of the silt and clay sized sediments were estimated using typical values for the free settling of individual particles, together with approximate erosional values associated with loosely consolidated muds. These values are given in Table 1.

Table 1. Sediment properties.

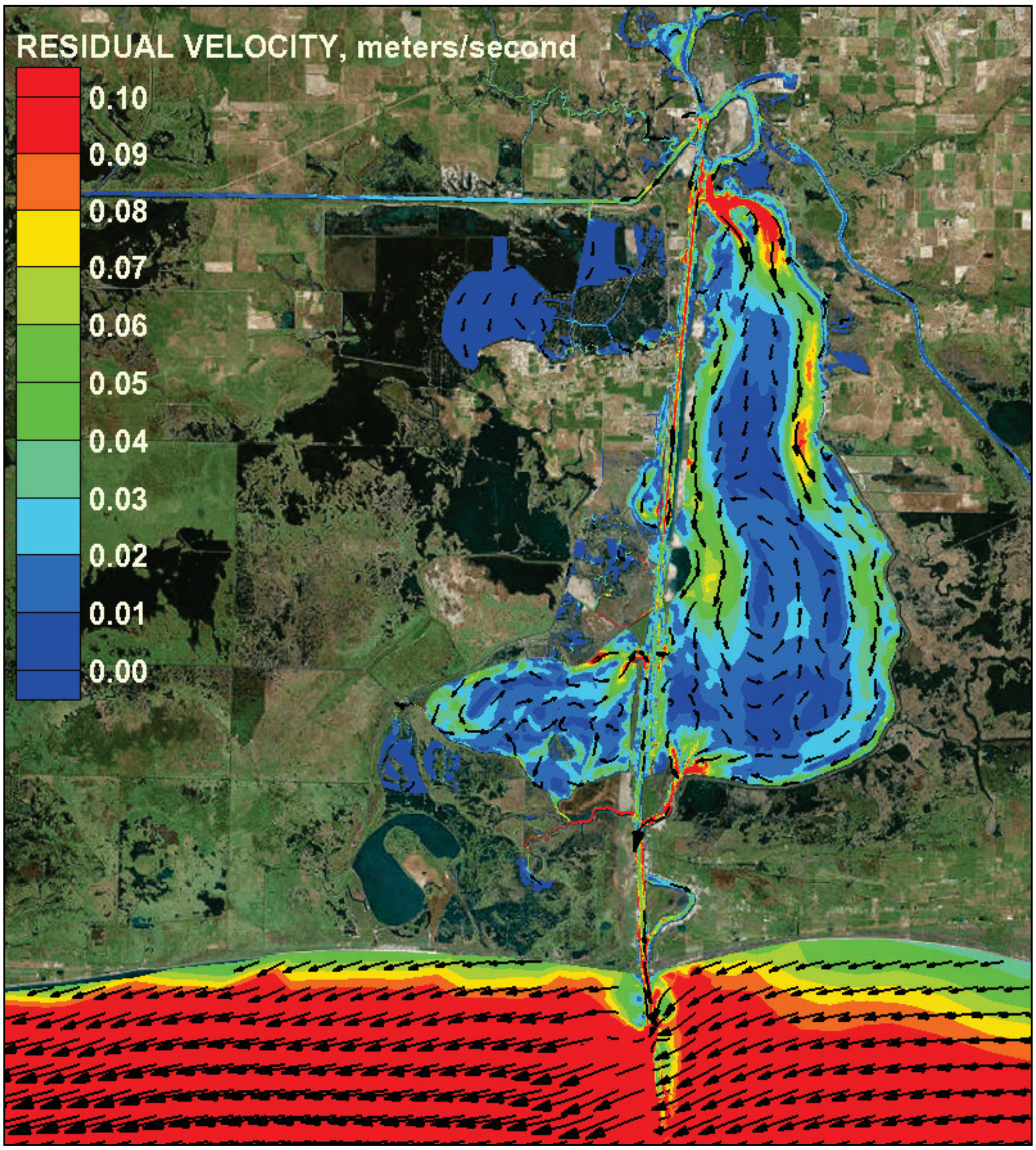
Sediment Class	Grain Size (mm)	Specific Gravity	Dry Bulk Density (kg/m^3)	Critical Shear Stress for Erosion (Pa)	Erosion Rate Constant ($kg/m^2/sec$)	Critical Shear Stress for Deposition (Pa)	Settling Velocity (mm/sec)
Clay	0.003	2.65	530	0.125	0.002	0.005	0.009
Very Fine Silt	0.006	2.65	530	0.125	0.002	0.01	0.036
Fine Silt	0.011	2.65	530	0.125	0.002	0.02	0.121
Medium Silt	0.023	2.65	530	0.125	0.002	0.04	0.529
Coarse Silt	0.045	2.65	530	0.125	0.002	0.075	2.025

[1] Fischenich, Craig G. 2004. Unpublished Draft. *Calcasieu River and Ship Channel Erosion and Sediment Impact Assessment (Phase 1)*. DRAFT report prepared for the US Army Corps of Engineers, New Orleans District. Vicksburg, MS: US Army Engineer Research and Development Center.

4.3 Numerical model results

Figure 6 is a plot of the residual circulation patterns for the model currents. Residual circulation is defined as the average circulation over several tidal cycles (in this case, over 96 hr). Residual circulation plots are very useful in understanding estuarine circulation since they illustrate the net transport pathways for the estuary. For this plot, the residual circulation is shown for a time period where a strong north wind is blowing across the estuary.

Figure 6. Residual velocities for north wind conditions.



Note that the westerly littoral current (imposed as a boundary condition) is apparent in the image. Note also that the residual circulation in the estuary induced by the north wind tends to result in strong currents along the lake shoreline. These currents can serve to transport sediments eroded by wave action at the shoreline along the shore and toward the CSC. These currents are qualitatively confirmed by Google Earth imagery of the southeast shoreline of Calcasieu Lake (Figure 7). This image is from 3/13/17 when the wind was 20 kn from the northeast. Note the entrainment of the freshwater plume into the clockwise current along the lake shoreline.

Figure 7. Google Earth image of clockwise nearshore current associated with north winds.

Figure 8 depicts the instantaneous concentration of very fine silt originating from the offshore sediment source, at maximum flood tide. Note there are significant concentrations of coastally derived sediments extending as far north as the GIWW intersection.

Figure 8. Instantaneous concentration of very fine silt originating from the offshore sediment source, at maximum flood tide.

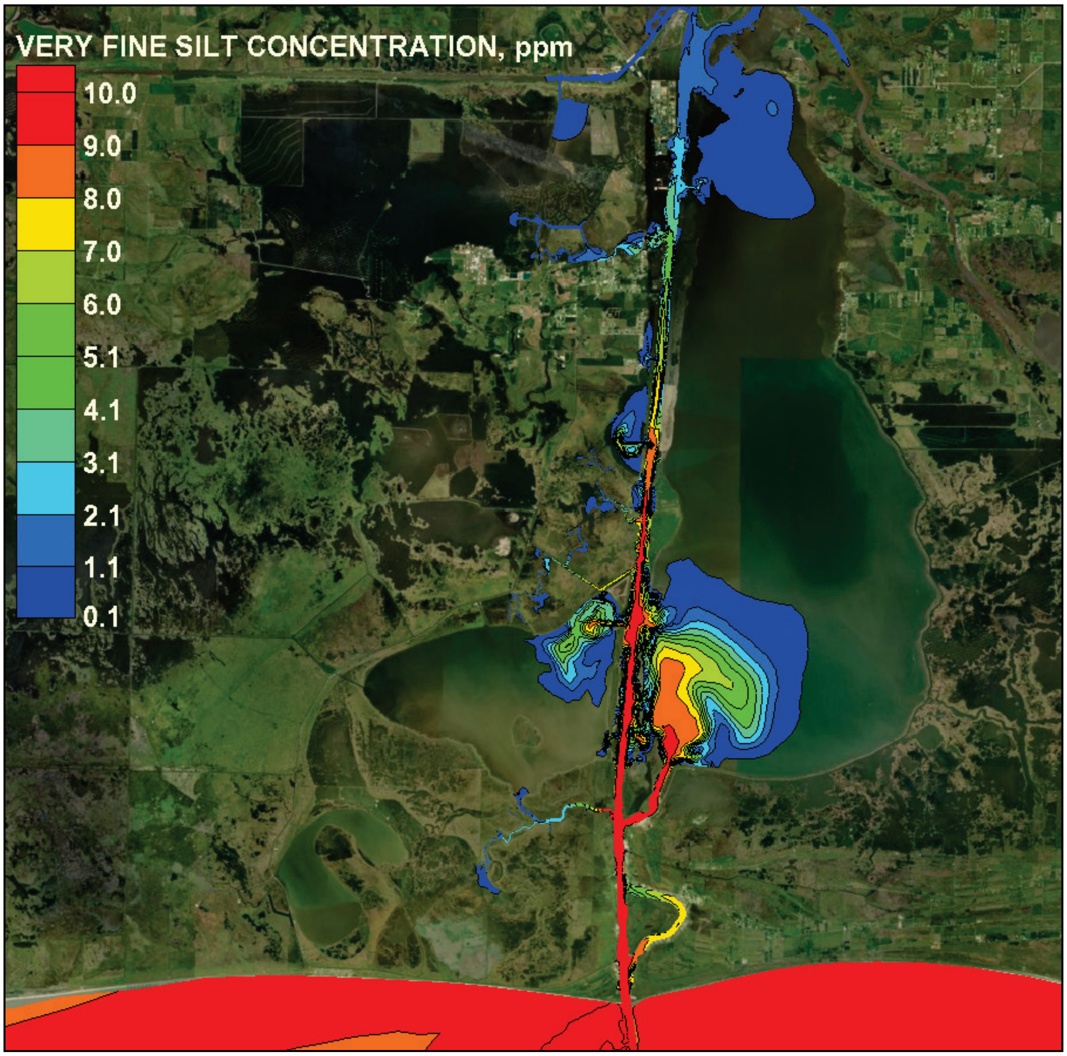


Figure 9 depicts the deposition patterns associated with coastally derived sediments. Figure 10 depicts the same deposition patterns, but the spatial extents are limited so that the in-channel deposition patterns can be seen. Note that the sediment tends to settle in Calcasieu Lake and along the sides of the CSC. This indicates that the forcing mechanisms applied in the model (i.e., depth-averaged tidal currents and wind-induced resuspension) may not be sufficient to rework the sediment until it finally settles in the channel. This suggests that other forcing mechanisms may play a role. Obvious candidates for these mechanisms include vessel effects (drawdown, near-vessel recirculation) and baroclinic circulation in the CSC. These mechanisms are discussed further at the end of this report.

Figure 9. Spatial deposition patterns of coastally derived sediments after 1 yr of model simulation.

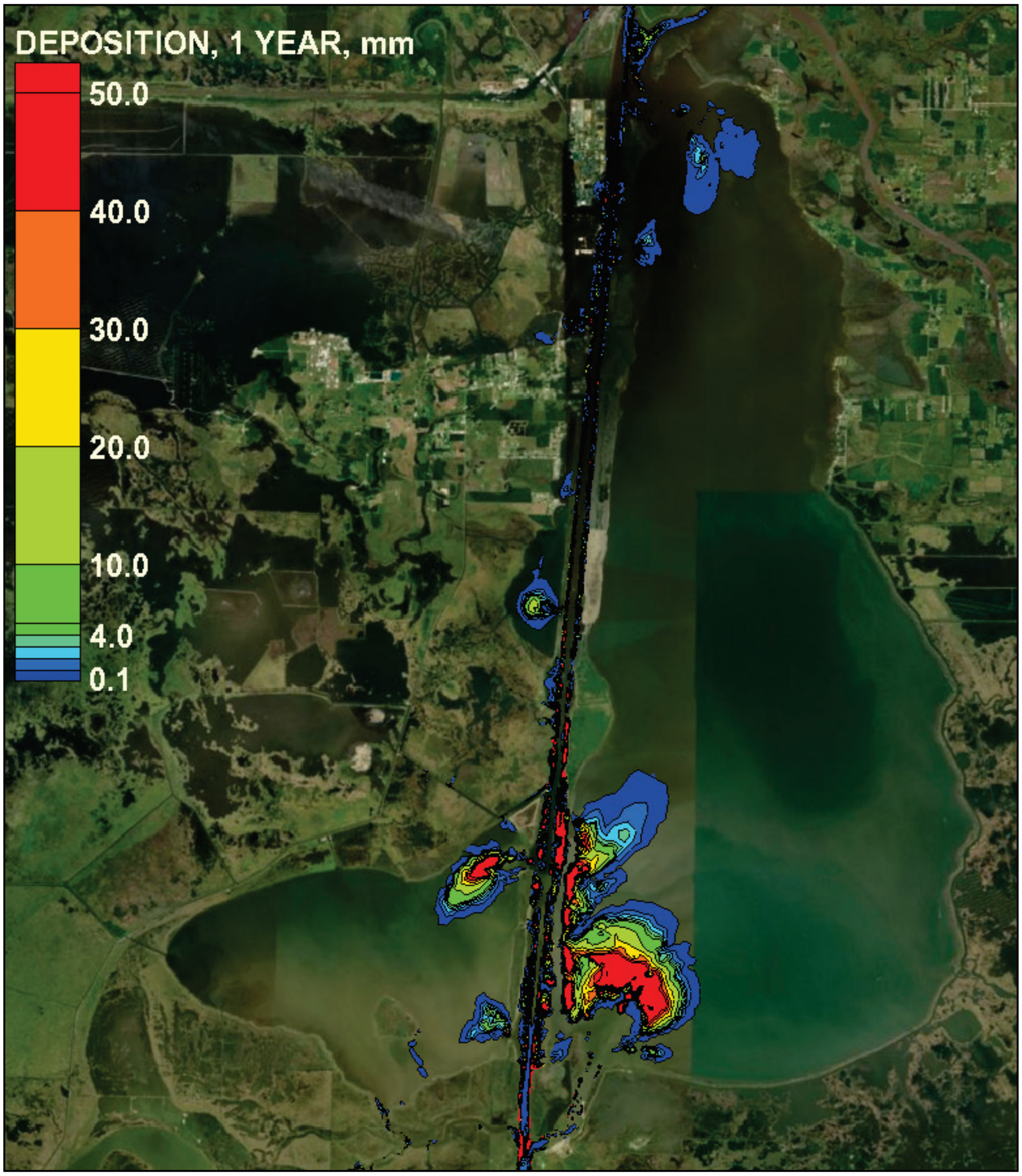


Figure 10. Spatial deposition patterns of coastally derived sediments after 1 yr of model simulation: in-channel deposition patterns.

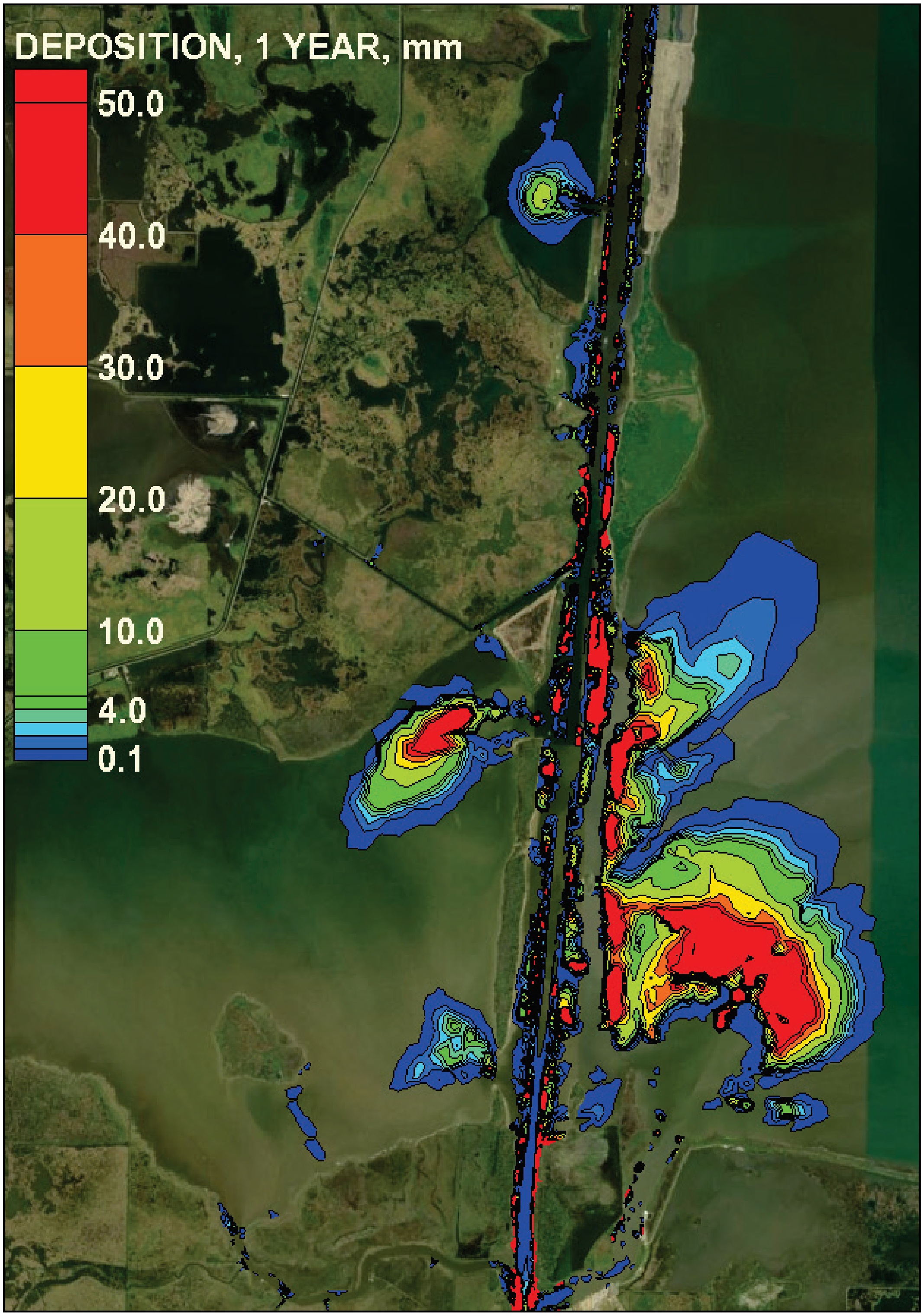
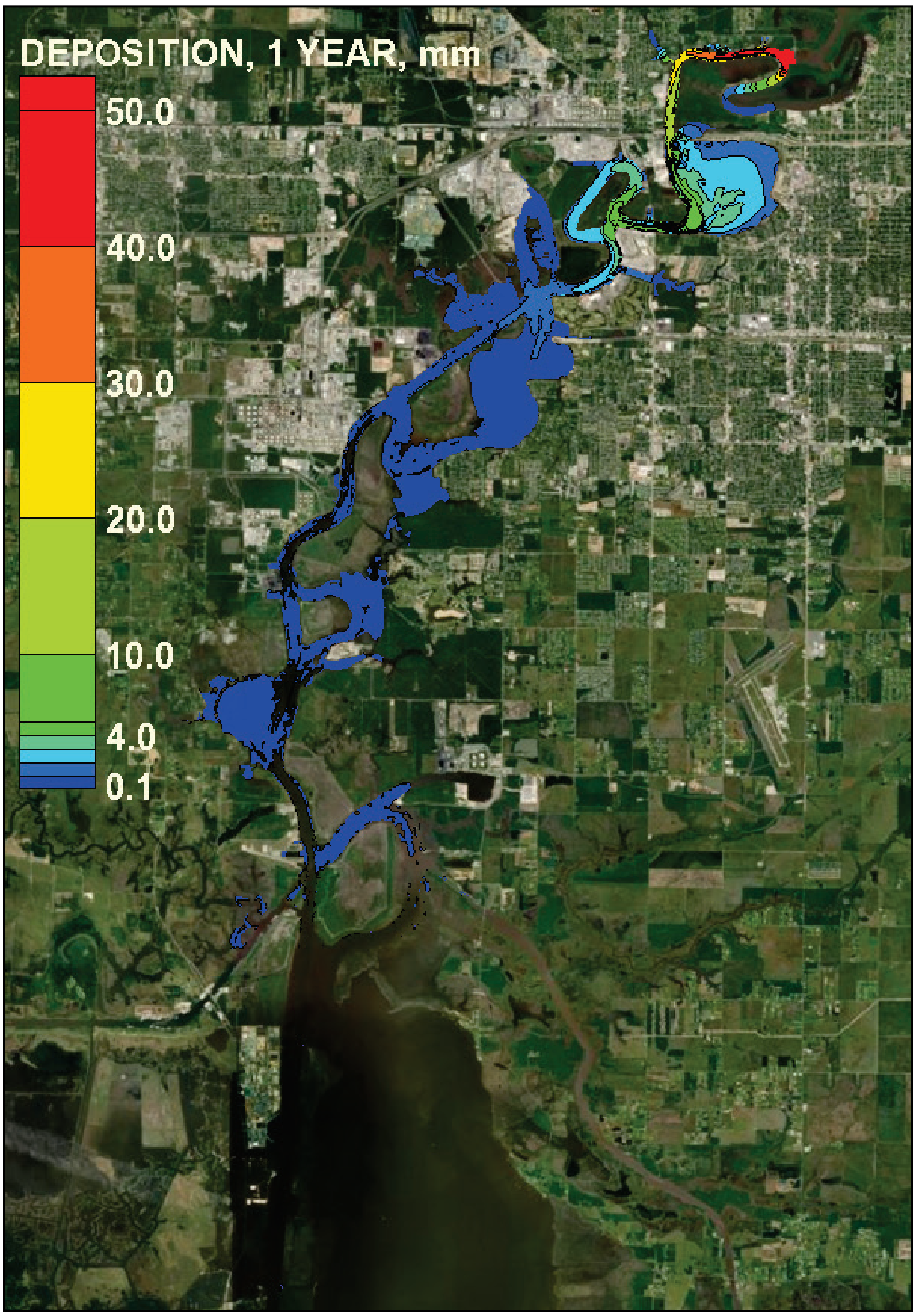


Figure 11 depicts the deposition patterns associated with the riverine sourced sediments. Note there is a tendency for them to settle out before they reach the lake. This may be consistent with the true deposition patterns, or, as with the coastally derived sediments, there may be a lack of some additional significant forcing mechanism in the present model (such as vessel effects) that serves to resuspend the sediments.

Figure 11. Spatial deposition patterns of coastally derived sediments after 1 yr of model simulation: in-channel deposition patterns.



4.4 Modeled estimates of sediment deposition in the CSC associated with coastally derived sediments

To estimate the annual contribution of coastally derived sediments to the sediment budget of Calcasieu Lake, the following procedure was followed:

- Three separate model simulations were completed, with offshore total suspended solids concentrations of 25, 50, and 75 ppm, respectively.
- For each simulation, the total mass of sediment passing through the CSC jetties and into the lake was measured.
- Using these data, a correlation was established between the offshore total suspended solids (TSS) concentration and the annual volume of sediment associated with offshore sources (expressed in terms of the estimated bulk density of the sediment deposited in the CSC of 530 kg/m^3).

This procedure yielded a simple, linear relationship between the offshore TSS concentration ($C_{TSS.O}$, in ppm) and the volume of sediment associated with offshore sources (V_{OS}, in yd^3/yr). That relationship is given in Equation 1.

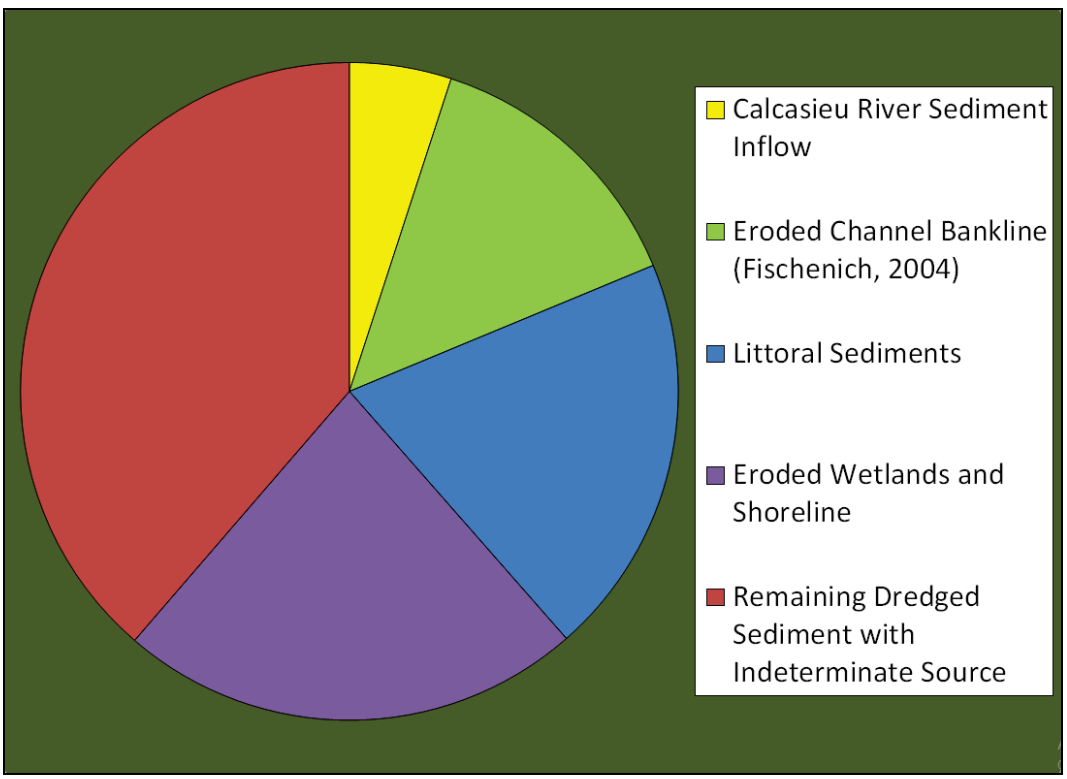
$$V_{OS} = 13350\ C_{TSS.O} \tag{1}$$

Hence, for an estimated offshore TSS concentration of 75 ppm (a gross estimate based on limited observations), the total contribution of the offshore sediments to the interior sediment budget is 13350 × 75 = 1,001,250 yd^3/yr.

5 Revised Sediment Budget

Utilizing the estimated volume of sediment attributable to offshore sources given by Equation 1, together with the average of the estimates of the volume of sediment attributable to wetland erosion (from 500,000 to 1,800,000 yd^3/yr, from Section 3.2 of this report), a revised sediment budget was generated. This is given in Figure 12. This sediment budget is generated with gross estimates of the quantities associated with the various sources, and hence there is significant uncertainty inherent in these quantities. It is possible that all the remaining portion of this budget that is attributed to indeterminant sources could be associated with the sources already identified. It is also possible that a significant fraction of the sediment deposition in this system is associated with one of the remaining sources not yet quantified, listed previously in this report. Further study is necessary to reduce the uncertainty associated with this sediment budget Some recommended studies are given below.

Figure 12. Spatial deposition patterns of coastally derived sediments after 1 yr of model simulation: in-channel deposition patterns.



6 Conclusions and Recommendations

6.1 Conclusions

The primary results of this study are given as follows:

- The conclusions from the original[1] sediment budget investigation were supplemented by estimates of the contributions from erosion of interior wetlands and from coastally derived sediments.
- It is assumed that most of the sediment that reaches the estuary is reworked by tides, wind-waves, vessel-generated waves and currents, and other means, until it eventually settles in the CSC or exits the system through Calcasieu pass.
- The contribution from the erosion of interior wetlands was estimated by converting USGS estimates of marsh edge erosion (Couvillion et al. 2017) to an estimated sediment mass contribution to the Calcasieu system.
- The contribution from the coastally derived sediments was estimated by applying an existing unvalidated numerical model of the system and using the model to estimate the potential for coastal sediment entrainment into the Calcasieu system for various estimates of the offshore sediment supply.
- These quantities were then used to update the sediment budget, together with some estimates of the uncertainties associated with this budget.

6.2 Recommendations

The following list of recommended studies are intended to further inform the two primary sources of uncertainty associated with sediment dynamics in the Calcasieu Lake system. These are (1) quantification of the sources of sediment to the system and (2) a full description the transport pathways that are responsible for delivering sediment from these various sources to the CSC.

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[1] Fischenich, Craig G. 2004. Unpublished Draft. *Calcasieu River and Ship Channel Erosion and Sediment Impact Assessment (Phase 1)*. DRAFT report prepared for the US Army Corps of Engineers, New Orleans District. Vicksburg, MS: US Army Engineer Research and Development Center.

- A sediment provenance study should be conducted. These studies utilize sediment samples collection in the field to determine identifying characteristics of the various sources of sediment to a system and characterize the collected samples in terms of the fraction of sediments associated with each source (Haughton et al. 1991).
- A field study of the influence of vessel effects on sediment resuspension should be conducted. Deep-draft vessels can have significant impacts of the resuspension and distribution of sediments in estuaries (Tate et al. 2008). Given that the model results in this study do not indicate that the typical annual wind-wave climate provides sufficient energy to redistribute the sediments that are deposited in Calcasieu Lake, it seems likely that vessel effects and/or storm waves are responsible for much of this redistribution.
- A field study of the interaction of the salt wedge in the CSC with sediment deposition and flocculation should be conducted. Typically, salt wedge dynamics place a dominant role in the location and distribution of fine sediments in estuarine channels (Fischer et al. 1979). These conditions should be studies in the CSC with field studies of both salinity and sediment settling characteristics, to determine how their interrelationship influences deposition in the CSC.

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14. ABSTRACT
The Calcasieu Ship Channel (CSC) is a deep-draft federal channel located in southwest Louisiana. It is the channelized lowermost segment of the Calcasieu River, connecting Lake Charles to the Gulf of Mexico. With support from the Regional Sediment Management Program, the US Army Corps of Engineers, New Orleans District, requested that the US Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory, perform an investigation of the potential sources of sediment associated with dredging in the CSC. A previous study had quantified sediment from known sources, indicating that the known sediment sources contribute approximately only 21% of the volume that is regularly dredged from the channel. This technical report details the results of the current study, which employed multiple methods, including numerical analysis, to identify potential additional sources of sediment by first examining the available literature and the modeled energetics and flow pathways, and then estimating the quantities of sediment associated with these identified sources that may be contributing to the shoaling of the CSC. The results of these efforts were used to update the original sediment budget with estimates of the contributions from two additional sources: the erosion of interior wetlands and coastally derived sediments.

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