Delta-X: Delft3D Sediment Model, Site 399, Terrebonne Basin, MRD, Louisiana, USA

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Summary

This dataset contains the Delft3D model of the intensive site 399 in the Terrebonne Basin along the Mississippi River Delta (MRD) in coastal Louisiana. Simulations cover the Delta-X Spring and Fall deployments in 2021 and include hydrodynamics and sediment transport. All files required to run the simulations are included. The model's output of water velocity and depth-averaged sediment concentrations are provided for both deployments. The dataset includes annual inorganic mass accumulation rates derived through modelling intra-annual variability in water levels and suspended sediment concentrations. The data are provided in netCDF format.

There are nine data files in netCDF (.nc4) format and two zip archives holding 22 set-up files required to run the simulations.

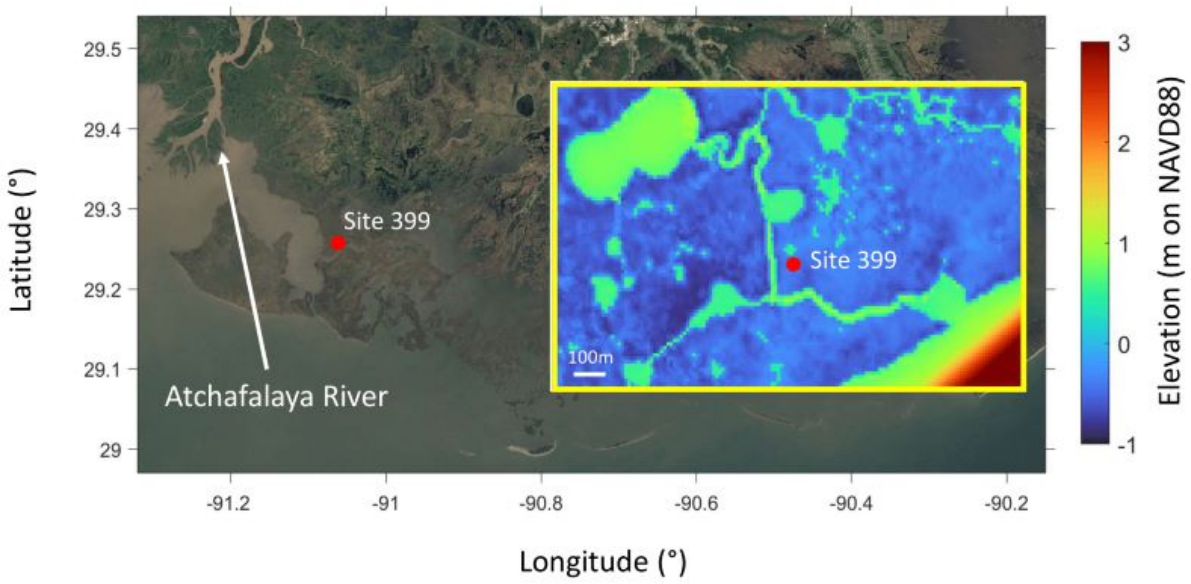

Figure 1. Satellite image of Terrebonne Bay, Louisiana, USA with location of Site 399. Inset shows bathymetry of this intensive site.

Citation

Donatelli, C., P. Passalacqua, and S. Fagherazzi. 2023. Delta-X: Delft3D Sediment Model, Site 399, Terrebonne Basin, MRD, Louisiana, USA. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2313

Table of Contents

1. Dataset Overview

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Project: Delta-X

The Delta-X mission is a 5-year NASA Earth Venture Suborbital-3 mission to study the Mississippi River Delta in the United States, which is growing and sinking in different areas. River deltas and their wetlands are drowning as a result of sea level rise and reduced sediment inputs. The Delta-X mission will determine which parts will survive and continue to grow, and which parts will be lost. Delta-X begins with airborne and in situ data acquisition and carries through data analysis, model integration, and validation to predict the extent and spatial patterns of future deltaic land loss or gain.

Related Dataset:

Cortese, L., and S. Fagherazzi. 2023. Delta-X: Delft3D Broad-Scale Sediment Model, Terrebonne Basin, MRD, Louisiana, USA. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2301

Cortese, L., X. Zhang, and S. Fagherazzi. 2023. Delta-X: Delft3D Broad-Scale Sediment Model, Atchafalaya Basin, MRD, Louisiana, USA. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2302

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Fichot, C.G., and J. Harringmeyer. 2022. Delta-X: AVIRIS-NG L3-derived Water Quality, TSS, and Turbidity, MRD, LA 2021, V2. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2112

Related Publication:

Cortese, L., C. Donatelli, X. Zhang, J.A. Nghiem, M. Simard, C.E. Jones, M. Denbina, C.G. Fichot, J.P. Harringmeyer, and S. Fagherazzi. 2023. Coupling numerical models of deltaic wetlands with AirSWOT, UAVSAR, and AVIRIS-NG remote sensing data, Biogeosciences. In review. https://doi.org/10.5194/bg-2023-108

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2. Data Characteristics

Spatial Coverage: Terrebonne Basin, Mississippi River Delta (MRD) floodplain, southern coast of Louisiana, USA

Spatial Resolution: 10 m

Temporal Coverage: 2021-03-25 to 2021-04-18 (Spring 2021 campaign) and 2021-08-12 to 2021-08-28 (Fall 2021 campaign)

Temporal Resolution: 1-hour time steps for model output

Site Boundaries: Latitude and longitude are given in decimal degrees.

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Terrebonne Basin	-91.1123	-91.0970	29.3044	29.2961

Data File Information

There are nine data files in netCDF (.nc4) format and two zip archives holding 22 set-up files required to run the simulations.

File naming convention for eight model output files: *site399_d3d_output_<var>_<campaign>.nc4*, where

- *<var>* indicates the output variable. See Table 1.
- *<campaign>* is either "Fall2021" or "Spring2021"

site399_IMAR.nc4 holds estimates of annual inorganic mass accumulation rates (imar).

User Note: In *site399_IMAR.nc4*, there is a line of "0" values along the north edge and a line "0" values along the east edge of the raster array that should be excluded from analysis.

Fall2021_Delft3D_setup_399.zip and *Spring2021_Delft3D_setup_399.zip* each hold 11 files in text format needed to execute the Delft3D simulation model for this particular location (Table 2).

Data File Details:

The netCDF files hold spatial data in an array georeferenced with projected coordinates in UTM zone 15N, WGS84 (EPSG 32615). The spatial resolution is 10 m.

The model output files hold simulation output for hourly time steps: Spring has 600 time steps. Fall has 408 time steps.

Table 1. Variables in netCDF files.

Variable	Units	Description
ssc_mud	kg m^{-3}	Depth averaged concentration of mud (cohesive)
u	m s^{-1}	East-west component of water velocity
v	m s^{-1}	North-south component of water velocity
wl	m	Water surface elevation above the NAVD88 vertical datum
imar	g cm^{-2} y^{-1}	Annual inorganic mass accumulation rate (IMAR): annual rates of mineral mass deposited on wetlands, estimated from analysis of storm frequency and deposition.

Table 2. Delft3D model input files included in *Fall2021_Delft3D_setup_399.zip* and *Spring2021_Delft3D_setup_399.zip*.

Filename	Description
145x85.grd	Computational grid definition
145x85.enc	Grid enclosure
bathymetry_399.dep	Elevation in meters of every cell (bathymetry) above and below NAVD88
boundaries.bnd	Boundary cells definition
BCs.bct	Boundary conditions
BCs_sediments.bcc	Boundary conditions of the sediment transport
chezy.rgh	Bottom roughness in every cell expressed as Chezy coefficient
critical_shear_stress.tce	Critical shear stress for erosion defined in each cell
morphology.mor	Parameters defining the morphological model
site_399.mdf	Master file for running the FLOW simulation
sediment_characteristics.sed	Parameters of mud fraction

3. Application and Derivation

Delft3d is a hydrodynamic model that is able to simulate water and sediment fluxes in coastal regions. Here, the model was employed to determine water levels, flow velocities and suspended sediment concentrations in the intensive site 399. Data produced by the model can be used in water quality studies that need physical variables such as suspended sediment concentration and water velocity.

4. Quality Assessment

To evaluate the performance of the numerical model, water levels were compared with: (i) field observations of water depth over the marsh, (ii) and water levels measured at the CRMS guage. In addition, the inorganic mass accumulation rates were compared with data of accretion available at the CRMS station.

5. Data Acquisition, Materials, and Methods

Study area

Terrebonne Bay is a deltaic lagoon located within the Mississippi Delta on the north coast of the Gulf of Mexico. The bay presents a series of narrow and low-lying barrier islands (the Isles Dernieres and Timbalier chains) that separate the back-barrier basin from the Gulf of Mexico. Tides are diurnal with a mean astronomical tidal range of 0.32 meters. Salt marshes in Terrebonne Bay heavily rely on wind processes to trap sediments and offset the deleterious effect of sea-level rise (Cortese and Fagherazzi, 2022). These data were focused on site 399, the location of intensive studies by Delta-X project. The site is one of Louisiana's Coastwide Reference Monitoring Systems (CRMS) sites.

Methods

Delft3D (Lesser et al, 2004; https://oss.deltares.nl/web/delft3d) was utilized to simulate water and sediment movements in the intensive site 399 (hereafter the fine scale model). The numerical model was run for March 25 to April 18 2021 (Spring campaign) and from August 12 to August 28 2021 (Fall campaign). Bathymetric information derived from lidar was given with respect to NAVD88. The numerical grid has a resolution of 10 m x 10 m. Water levels measured at the CRMS station, and suspended sediment concentrations extracted from a broader scale model (see Cortese et al., 2023 for details) were imposed on the left end of this fine scale model. The broad scale model, due to its coarser spatial resolution, is not able to determine water levels and suspended sediment concentrations on the other two boundaries of the fine scale model. As such, Neumann boundary conditions and zero suspended sediment concentrations were imposed on these two boundaries. This choice implies that the numerical results are only reliable along channel 1, while water levels and sediment deposition over the marsh along channels 2 and 3 must be discarded (Figure 1 inset).

Bottom friction was imposed in terms of Chezy coefficients similar to Zhang et al. (2022) and Cortese et al. (2023). A single sediment class was considered for site 399: mud (cohesive fraction). Sediment parameters of settling velocity and critical bed shear stress for erosion were calibrated using TSS maps derived from AVIRIS-NG data (Fichot and Harringmeyer, 2022). Water-level validation was performed by comparing the results of the fine scale model with: (i) water levels measured at the CRMS guage and (ii) field observations of water depth over the marsh.

Derivation of inorganic mass accumulation rates

The inorganic mass accumulation rates (IMAR) were obtained by assuming that the two simulated periods (i.e., March 25 to April 18 2021 and August 12 to 28 2021) were able to capture the intra-annual variability in water levels and suspended sediment concentrations within the selected area. The inorganic mass accumulation computed for the Spring campaign was multiplied by a scale factor to account for half a year. Inorganic mass accumulation

computed for the Fall campaign was multiplied by a scale factor to account for the second half of a year. Then, the two contributions were summed to obtain the yearly inorganic mass accumulation rates.

More details are available in Cortese et al. (2023).

6. Data Access

These data are available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

Delta-X: Delft3D Sediment Model, Site 399, Terrebonne Basin, MRD, Louisiana, USA

Contact for Data Center Access Information:

- E-mail: uso@daac.ornl.gov
- Telephone: +1 (865) 241-3952

7. References

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