

EEMS Demonstration Model Description

DM_Tra_Khuc_Sediment_Transport

1 Objective

This demonstration model uses EFDC+ Explorer (EE) and EFDC+ to simulate hydrodynamics, salinity intrusion, and sediment transport in the Trà Khúc Estuary, Vietnam. Two alternative sediment transport configurations are provided on an identical grid and with identical hydrodynamic and salinity forcing:

- **Original Sediment Model:** the native EFDC+ sediment transport sub-model, with separate cohesive and non-cohesive sediment classes.
- **SEDZLJ Model:** the SEDZLJ sediment transport sub-model, with a single unified set of size classes and core-based bed erosion properties.

Because the two configurations share the same grid, bathymetry, inflow, and open-boundary forcing, they demonstrate how the choice of sediment sub-model affects simulated suspended sediment transport in a tidally forced coastal estuary.

2 Model Description

The configuration common to both models is summarized in Table 1 and the model domain is shown in Figure 1. The domain represents the Trà Khúc river channel and its estuarine fan at the river mouth, with bottom elevations ranging from -19 m (offshore ocean domain) to $+5$ m (upper estuary). Each configuration is run for 10 days with a dynamic time step and a maximum step of 3 s.

Table 1 Model configuration common to both sediment configurations

Run Period (days)	Horizontal Cells	Vertical Layers	Activated Modules
10 (2018-01-01 to 2018-01-11)	2,204 active cells (89×46 grid)	• 5 water column layers (standard sigma) • Bed layers: 4 (Original), 7 (SEDZLJ)	• Hydrodynamics • Salinity • Sediment Transport

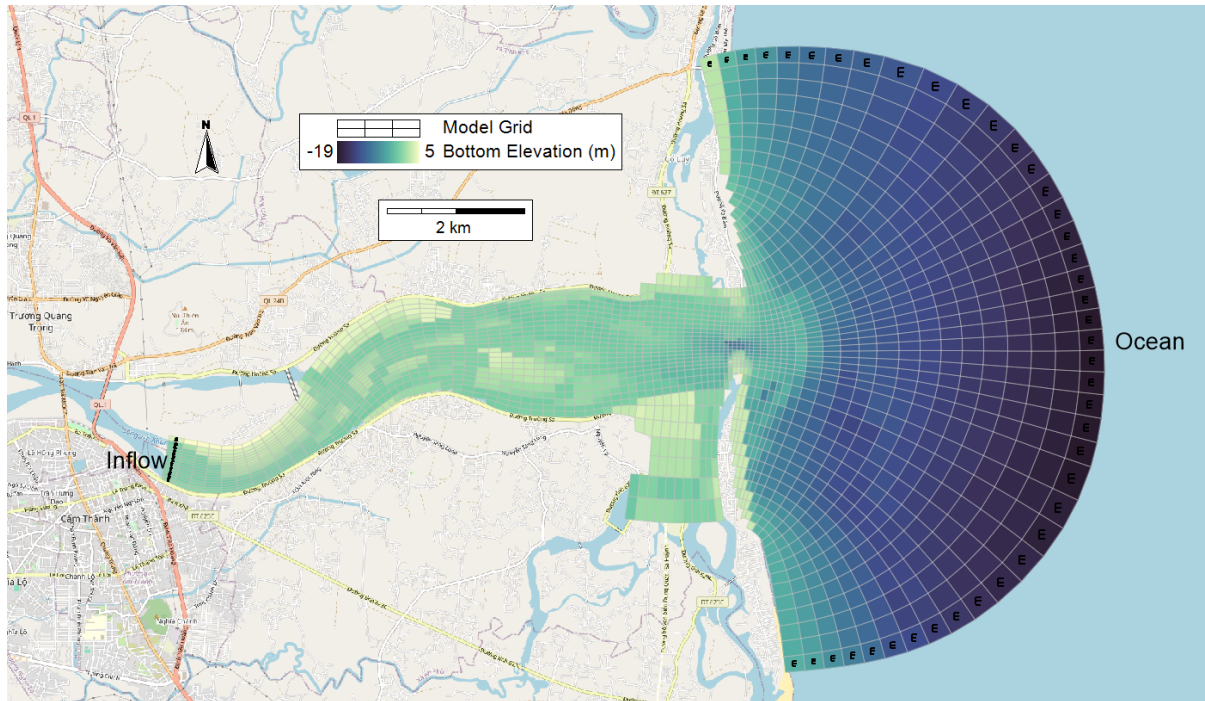


Figure 1 Model domain with the semicircular offshore domain representing the open ocean boundary.

2.1 Hydrodynamic Configuration

Both configurations use identical hydrodynamic settings on the same curvilinear grid, with 5 equal sigma layers. Wetting and drying is activated with a dry depth of 0.05 m and a wet threshold of 0.10 m. Salinity module is activated.

The upstream boundary is driven by a single daily flow time series (series 1, “River”) distributed uniformly over the five vertical layers. The downstream open boundary is driven by a water surface elevation time series (series 1, “Tides”) supplied at hourly intervals. Spatially varying initial conditions for salinity and bed roughness are applied.

3 Sediment Transport Configuration

The two configurations differ only in the sediment transport sub-model and its bed representation. The differences are summarized in Table 2.

Table 2 Comparison of the two sediment transport configurations

Attribute	Original Sediment Model	SEDZLJ Model
Sediment sub-model	Native EFDC+	SEDZLJ
Sediment classes	1 cohesive and 3 non-cohesive	6 unified size classes
Size range represented	100–1,000 μm for the non-cohesive classes; no diameter assigned to the cohesive class	10–4,000 μm
Bed layers	4 (3 with non-zero initial thickness)	7 (5 with non-zero initial thickness)
Bed initial conditions	Spatially uniform across all cells	Three representative cores mapped to the grid
Initial bed dry mass	Approximately 1,590 kg/m^2 everywhere	891 to 1,445 kg/m^2 depending on core
Bed load	Activated for each non-cohesive class	Activated, with a 64 μm cutoff
Inflow sediment load	9.57 mg/L cohesive plus 0.957 mg/L in each non-cohesive class	9.57 mg/L in the finest class only

3.1 Sediment Boundary Conditions

Sediment inflow concentrations at the upstream boundary are specified from `River_Cohesives.dat` and `River_Non-Cohesives.dat`, both of which decrease slowly over the length of the series. At the start of the simulation, the cohesive concentration is 9.57 mg/L and the non-cohesive concentration is 0.957 mg/L .

In the Original Sediment Model the cohesive value is applied to the single cohesive class and the non-cohesive value is applied to each of the three non-cohesive classes, giving a total inflow concentration of approximately 12.4 mg/L . In the SEDZLJ Model the cohesive value is applied to the finest size class and the remaining five classes carry no inflow, giving a total inflow concentration of 9.57 mg/L . The open ocean boundary carries zero sediment concentration for all classes in both configurations.

3.2 Original Sediment Model

The native EFDC+ sediment transport sub-model is used with one cohesive class and three non-cohesive classes, distributed over four bed layers. Class parameters are listed in Table 3.

Table 3 Sediment class parameters, Original Sediment Model

Class	Type	SSG	w_s (m/s)	d_{50} (m)
SED1	Cohesive	2.65	1.0×10^{-5}	–
SND1	Non-cohesive	2.65	7.788×10^{-3}	1.00×10^{-4}
SND2	Non-cohesive	2.65	9.764×10^{-2}	7.50×10^{-4}
SND3	Non-cohesive	2.65	1.399×10^{-1}	1.00×10^{-3}

Cohesive resuspension uses a reference surface erosion rate of 5×10^{-4} $\text{g}/\text{m}^2/\text{s}$. Non-cohesive transport uses an equilibrium concentration formulation, with critical Shields parameters of 0.0949, 0.0298, and 0.0332 for SND1 through SND3 respectively, and bed load activated for each class.

Bed initial conditions are spatially constant. Layer thicknesses are 0.50, 0.48, and 0.02 m for layers 1 through 3, with the fourth layer given zero initial thickness. A wet bulk density of 1,989.99 kg/m^3 and a porosity of 0.40 are applied in every layer. Each of the four sediment classes is assigned an initial mass fraction of 0.25 in each active layer.

3.3 SEDZLJ Model

The SEDZLJ sub-model is used with six size classes spanning 10–4,000 μm over seven bed layers. Global class parameters listed in Table 4. The variable bed option is activated with a maximum of 7 layers, and a bed load cutoff of 64 μm .

Table 4 Size class parameters, SEDZLJ Model. Critical stresses are given in the input units of dynes/cm² with the Pa equivalent in parentheses.

Class	d_{50} (μm)	$\tau_{\text{cr,erosion}}$	$\tau_{\text{cr,suspension}}$	w_s (m/s)
		dynes/cm ² (Pa)	dynes/cm ² (Pa)	
1	10	1.0 (0.10)	1.0 (0.10)	6.71×10^{-5}
2	22	2.2 (0.22)	2.2 (0.22)	3.24×10^{-4}
3	222	1.6 (0.16)	2.4 (0.24)	2.25×10^{-2}
4	375	2.4 (0.24)	3.5 (0.35)	4.45×10^{-2}
5	750	3.8 (0.38)	12.5 (1.25)	8.83×10^{-2}
6	4,000	30.8 (3.08)	98.8 (9.88)	2.73×10^{-1}

Bed erosion properties are specified per sediment core and mapped to the grid. The underlying field dataset consists of 72 measured bed cores, with locations given in `SedCores.Location.dat` and layer-by-layer dry bulk density, specific gravity, and grain size distribution given in `Tra_Khuc_Sed_Cores.dat`. These measurements are grouped into three representative cores, designated Riverine, Floodplain, and Marine, which are assigned to 783, 598, and 823 cells respectively. Core properties are summarized in Table 5. Each core additionally carries a tabulated erosion rate surface, defined at eight applied shear stresses from 0 to 128 dynes/cm² for each of the seven bed layers. The Marine core is assigned uniformly negligible erosion rates of 1×10^{-12} cm/s at every applied stress, effectively treating the offshore bed as non-erodible.

Table 5 SEDZLJ sediment core properties from `erate.sdf`

Core	Cells	Layer thicknesses (cm, layers 1–7)	Dry bulk density (g/cm ³)	Size class distribution (%)
1 – Riverine	783	0, 0, 15, 15, 15, 15, 40	0.562–0.964 (graded)	13, 57, 24, 5, 1, 0
2 – Floodplain	598	0, 0, 10, 20, 20, 20, 30	0.642–1.478 (graded)	1, 1, 80, 15, 2, 1
3 – Marine	823	0, 0, 10, 10, 20, 30, 30	1.445 (uniform)	1, 1, 80, 15, 2, 1

Critical shear stresses for erosion vary by layer within each core, ranging from 2 to 7 dynes/cm² over the erodible layers, with a value of 999 dynes/cm² assigned to the lowest layer to represent a non-erodible base. Layers 1 and 2 are assigned zero initial thickness in all three cores; they represent the active and deposited layers, which develop during the simulation.

4 Folder Structure

The model package contains the following components:

- **Original Sediment Model:** The complete EFDC+ Original Sediment Model model project directory, loadable directly in EFDC+ Explorer for pre- and post-processing.
- **SEDZLJ Model:** The complete EFDC+ SEDZLJ Model model project directory, loadable directly in EFDC+ Explorer for pre- and post-processing.
- **Data:** Input data organized into three subfolders:

- *Bathymetry*: Bathymetry.dat, Domain.p2d
 - *Boundaries*: BC_Inflow.dat, BC_Water_Level.dat, IC_Bot_Roughness.dat, IC_Salinity.dat, IC_WSEL.dat, River_Cohesives.dat, River_Non-Cohesives.dat, SedCores_Location.dat, Sediment_Settings.xlsx, Tra_Khuc_Harmonic_Constant.dat, Tra_Khuc_Sed_Cores.dat, TS_Cohesive_sediment.dat, TS_Non-Cohesive_sediment.dat, Winds.dat
 - *Outline*: Center_Line.p2d, LPT_Region01.p2d, LPT_Region02.p2d
- **Grid**: Tra_Khuc.gpc (GridPlus format for EE), Tra_Khuc.kml (viewable in Google Earth).
 - **Maps-Images**: Geo-referenced imagery of the study area (Tra_Khuc.jpg, Tra_Khuc.jgw).

5 Model Results

Figures 2 and 3 show the plan-view depth-averaged total suspended sediment (TSS) field at the end of the simulation for the Original and SEDZLJ configurations, respectively.

In both configurations, TSS is confined almost entirely to the Trà Khúc river channel, with the semicircular offshore domain remaining near zero throughout. The sediment plume advects eastward along the channel and reaches the river mouth, where concentrations decrease sharply as the flow expands into the offshore domain.

The two configurations differ in both the magnitude and the along-channel distribution of TSS. The Original model produces moderate concentrations distributed relatively evenly along the mid- and lower-channel reach, with isolated high-concentration cells near the river mouth. The SEDZLJ model produces higher concentrations concentrated in the upstream channel bend, and a more coherent plume that decreases progressively downstream toward the mouth. This pattern is consistent with the SEDZLJ configuration's core-based bed properties, in which the Riverine core assigned to the upper channel has the lowest dry bulk densities and readily erodible surface layers, while the Marine core assigned to the offshore area is effectively non-erodible.

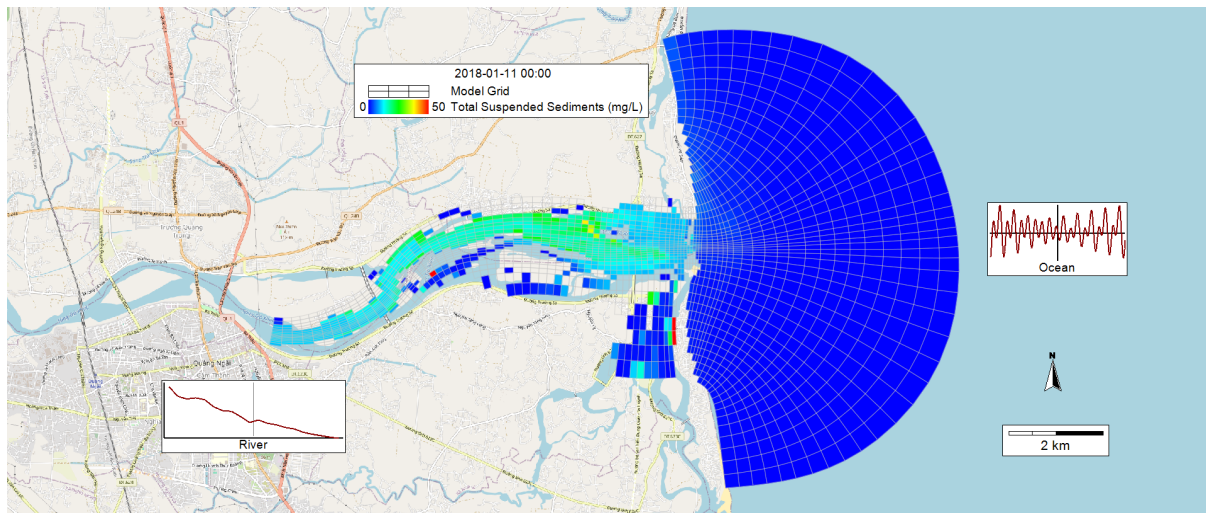


Figure 2 Plan-view depth-averaged TSS at the end of simulation, Original Sediment Model.

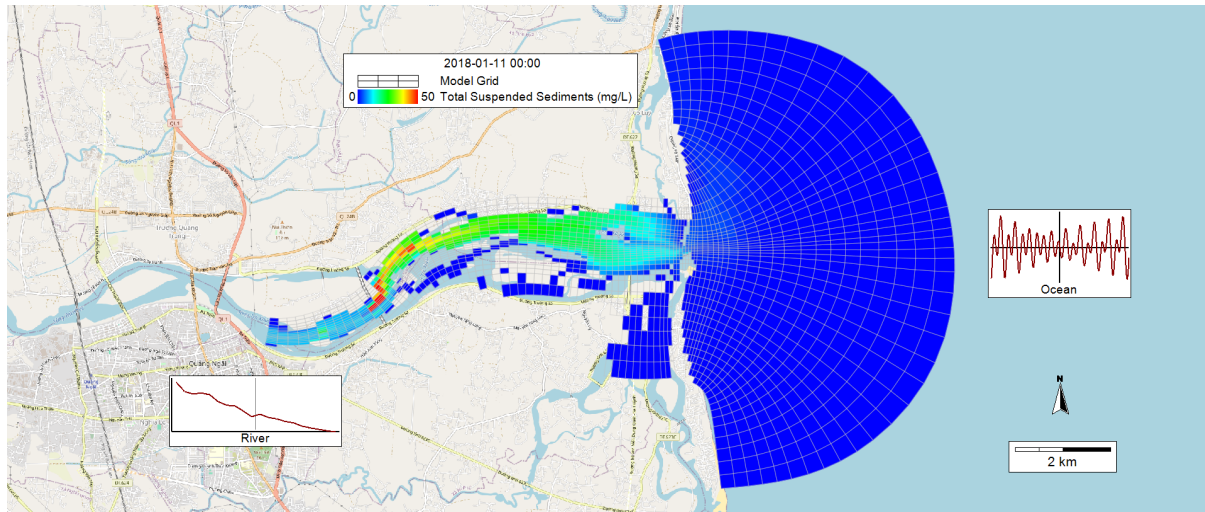


Figure 3 Plan-view depth-averaged TSS at the end of simulation, SEDZLJ Model.

6 Notes

6.1 Disclaimer

This model is provided to demonstrate that EFDC+ Explorer and EFDC+ can be used to build and analyze this type of models. The simulation results are consistent with expected behavior; however, the model should not be considered a final or validated product. Users are encouraged to review, modify, and refine model parameters to obtain results appropriate for their specific application.

6.2 EEMS Demo Mode

In Demo mode, the model is validated against a set of predefined signatures, including grid size, domain area, center coordinates, transport count, and module configuration. While certain parameter values may be adjusted, the grid cannot be modified, transports cannot be added, and the prescribed module setup cannot be altered. Any deviation from these conditions results in the model no longer being considered a valid demo model.

6.3 Support

For technical support, additional documentation, or to obtain the latest version of EFDC+ Explorer, please visit: www.eemodelingsystem.com