SEDIMENT TRANSPORT AND GO-CONG MORPHOLOGICAL CHANGE MODELING BY TELEMAC MODEL SUITE

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1. INTRODUCTION

This report presents the simulation of hydrodynamics and morphology of the LMDCZ.

2. OBJECTIVES

To understand the mechanism responsible for the erosion/accretion process in the LMDCZ and the coastal zones of Go-Cong. To define the boundary conditions for the detail study areas at Go Cong

3. METHOLOGY

In order to achieve the objectives of WP5 of the LMDCZ project, the main solution of the project is to use the numerical models (Figure 3-1) to simulate hydrodynamic and morphologic regimes of the estuarine and coastal areas, verified by the in-situ survey data.

Model 1 (Regional model) is a hydrodynamic model for the entire East Sea of Vietnam and the Gulf of Thailand. The model used for this study area is the MIKE 21 Coupled FM with HD module (hydrodynamic), SW (spectral wave). The purpose of model 1 is to simulate flow regime (tide, coastal current) and wave regime to provide opening boundaries for smaller models (group 2).

The model group 2 (Local model) includes: (i) 1D for the Mekong river system and Saigon - Dong Nai, and (ii) 2D for the study area from Ba Ria - Vung Tau to Cambodia. The results of these model are used to extract the boundaries for the detailed model (model group 3). For the stand-alone 1D models, the modules used will be MIKE 11 HD, AD. For standalone 2D models, the modules used are MIKE 21 FM HD, SW and MT.

The model group 3 (detailed models) consists of detailed 2D models designed to study hydrodynamic regime, sediment transport and morphological changes in the studied and adjacent areas. The modules of the MIKE are used similarity to the regional model.

With nesting approach, MIKE21 has been calibrated well from the Regional model to Local Model with water levels, discharges, tides, waves and currents, especially the validation results based on the in-situ data of the LMDCZ project in October 2016 and February-March 2017, presented in WP4 Report.

This WP5 Report we discuss the sediment transport in the regional of LMDCZ and Go Cong area.

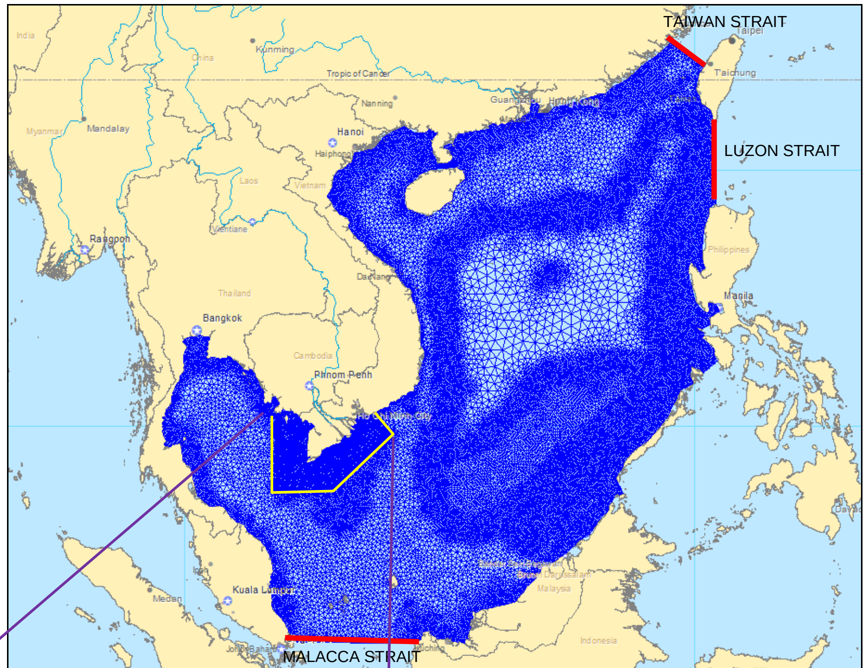

Figure 3.1: RCMmodel

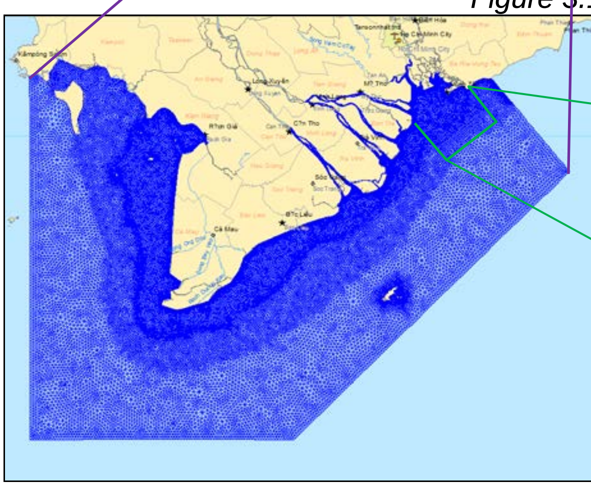

Figure 3.2: Extended Model (A)

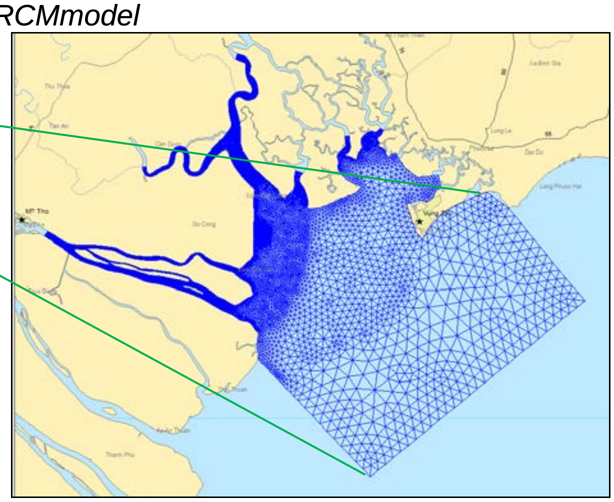

Figure 3.3: Local Model (B)

4. MODEL CALIBRATION, VALIDATION OF SEDIMENT TRANSPORT AND MORPHOLOGY IN THE LOCAL AREA

4.1. Input Data Processing

4.1.1. Wave model setup of the whole South China Sea

Forecast tidal levels are used at open boundaries of the model. These tidal levels were predicted based on the harmonic constituents obtained from the analysis of global tidal data monitored with satellites and corrected with real measured data. All datasets are integrated within **FES2014** database.

Wave heights, periods, frequencies, directions for the Malacca, Luzon and Taiwan straits are extracted from WAVEWATCH-III database.

4.1.2. HD and sediment transport modeling in the extended study area

Upstream open boundaries at river estuaries are 7discharge boundaries. Two of discharge boundaries are located near the hourly observed station so they are provided with real discharge data. For the 5 other boundaries, flow data are generally extracted from the results of the 1D hydrodynamic model (MIKE11). The mentioned above 1D model has been established, calibrated, validated and used by the SIWRR in different research projects in the recent several years, so the model is highly reliable. In the wave model, these boundaries are assumed to be closed boundaries (land or wall boundary).

4.1.3. 2D Hydrodynamic and sediment transport model in the detailed study area

For upstream discharge boundary, the discharge data used are similar to model A. For the seaward open boundaries, water level data used are extracted from simulation results of model A.

For the wave model, seaward open boundaries are extracted from the wave simulation results of model A. Upstream boundaries are also assumed to be Land Boundary (Closed Wall).

4.1.4. Topographic data

The topographic data used in this study were inherited from different sources and earlier researches:

- For estuarine areas (Soai Rap, CuaTieu, Cua Dai, Ham Luong) and coastal areas of Go Cong, Can Gio and the GanhRai Gulf, the topographic data is extracted from the surveying reconnaissance of 1/5.000 scale topographic plane.

In the years 2008, 2009, and 2010, under the framework of the Baseline Survey Project implemented by the SIWRR and the ICOE as well as survey work-package of this research.

- For coastal areas from HCMC to KienGiang, the topographic data was extracted from the map (scale of 1/100,000) published by the Navy in 1982.
- The topography in other areas of the South China Sea was extracted from the SRTM30_PLUSV6.0 database from the Scripps Institution of Oceanography, Californian University, USA. This is a dataset with 30"×30" resolution, constructed from the satellite-gravity model, in which the gravity-to-topography ratios are corrected by 298 million ADCP depth points.

4.1.5. Wind field data

Wind field data is the most important input parameter for the wave computation model. The background wind data used in this study derived from the modeling results of the Climate Forecast System Reanalysis (CFSR) of the National Center for Environmental Prediction, the part of the US National Oceanic and Atmospheric Administration (NCEP/NOAA). The wind field results obtained from the *"reanalysis"* simulation, which includes the model validation with the measured data from the global marine observation stations system so the data should be highly reliable. This wind field data is from 1979 ÷ 2009 with a time step of 1 hour and a grid size of $0.312^o \times 0.312^o$. This is a very good dataset for the wind and weather research.

4.1.6. Wave field data

The wave and wind data collected at Bach Ho drilling platform in 1996 was collected for the model calibration and validation purposes. The wind data used to verify the reliability of wind data extracted from the CFSR model. The wave data used to verify the TOMAWAC model.

The satellite-monitored wave data used to calibrate the South China Sea model in this research was provided by France's AVISO organization. Concretely, the datasets are combined in Ssalto/Duacs wave-field toolset (compiled from wave monitored by different satellite system such as Jason-1 and Jason-2, Topex/Poseidon, Envisat, GFO, ERS-1 and ERS-2, and Geosat). This data only includes significant wave height, with a time step of 1 day, a coarse $1^o \times 1^o$ space grid, and is available from September 14, 2009 to present.

The wave simulation results of the WAVEWATCH-III model used for comparison with the TOMAWAC results are also provided by NCEP/NOAA. This dataset includes such wave components as significant wave height, maximum wave period, and average main wave direction. The data has a time step of 3 hours, $0.5^o \times 0.5^o$ space grid, available from 2005 to present.

4.1.7 Sediment data

In this research, we used suspended sediment data at My Thuan station as boundary conditions at Song Tien River, observed within the scope of this project. For the boundaries at the Saigon-Dong Nai River Estuary, due to the lack of regular monitoring stations, the suspended sediment data at this boundary were obtained by averaging from observation data of Basic Survey Projects conducted by the SIWRR in 2003 - 2008.

4.1.8. Reprogram Telemac2d and Tomawac model

Along with a huge number of advantages, the chosen Telemac-Mascaret Modeling Suite has certain important drawbacks that strongly limit the accuracy of the model. For example:

- *Tomawac:*Wave data (*height, direction, frequency, period, spreading*) can only be inserted into the model as unique value per time for each boundary line (only 1 time series for each boundary line).
- *Tomawac:* Wave Spectrum cannot be inserted into the boundaries.
- *Telemac:* H and UV boundary can also be inserted into the model only as unique value per time for each boundary line(only 1 time series of U,V and H for each boundary line).

SIWRR modeling team has re-programmed (recoded) all related to boundary data structure and boundary value propagation in the computational domain.

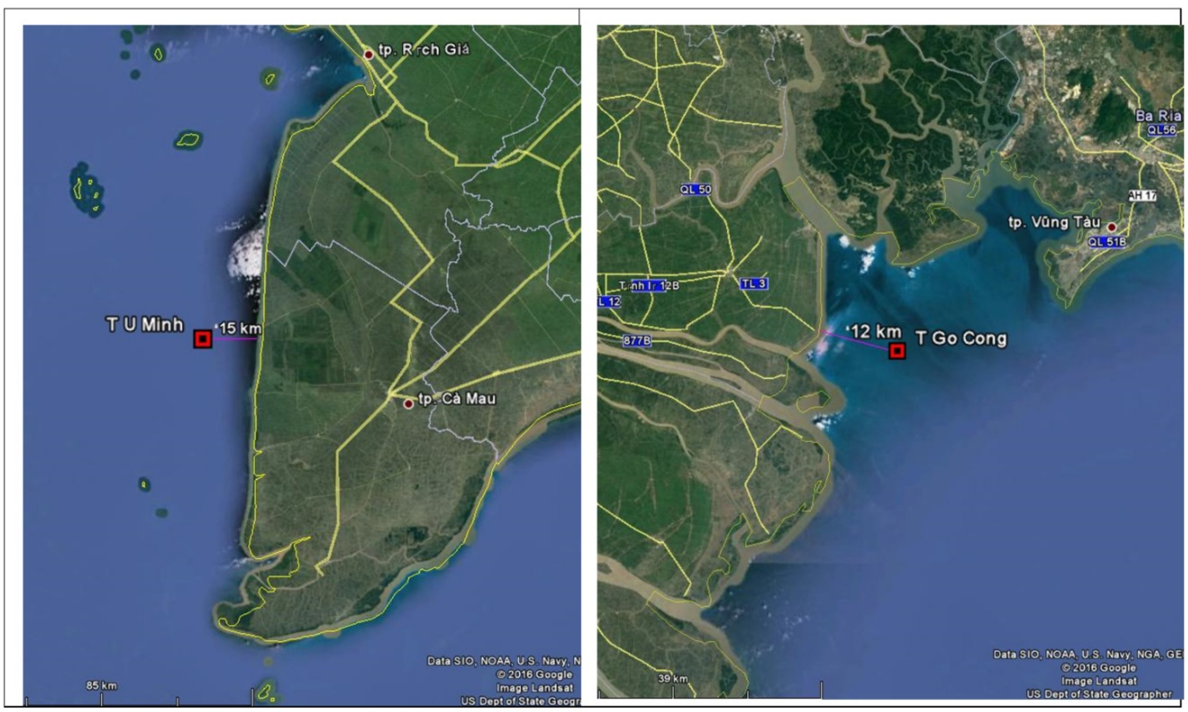

Figure 4.1: Locations of U Minh and Go Cong wind, waves, currentsand salinity measurement stations

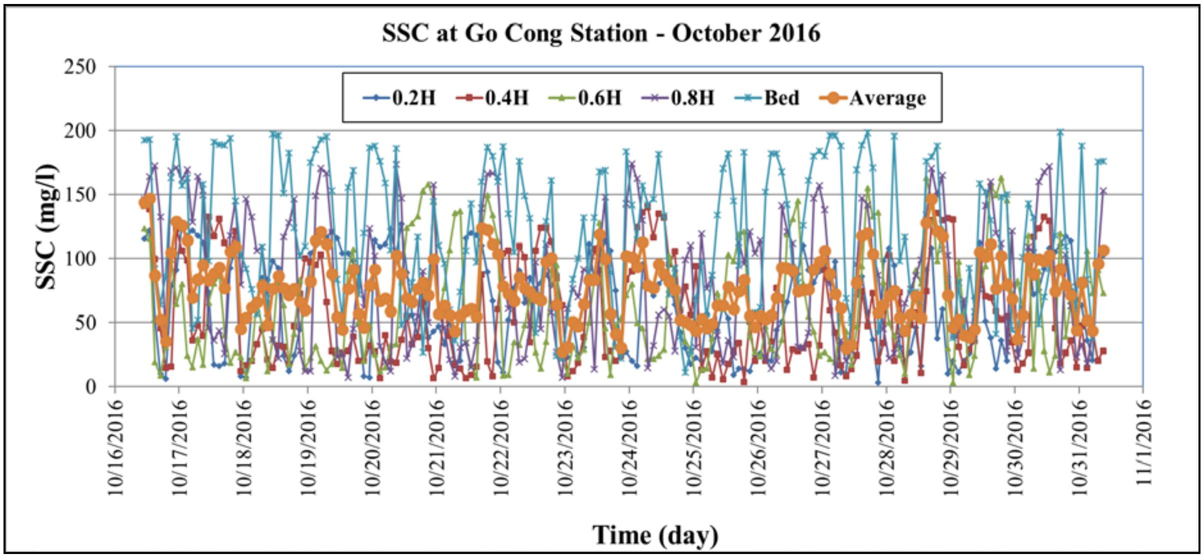

Figure 4.2: Average suspended and Bottom SSC concentrations at Go Cong observation site of the 1-st Surveying Campaign (16-30 October 2016)

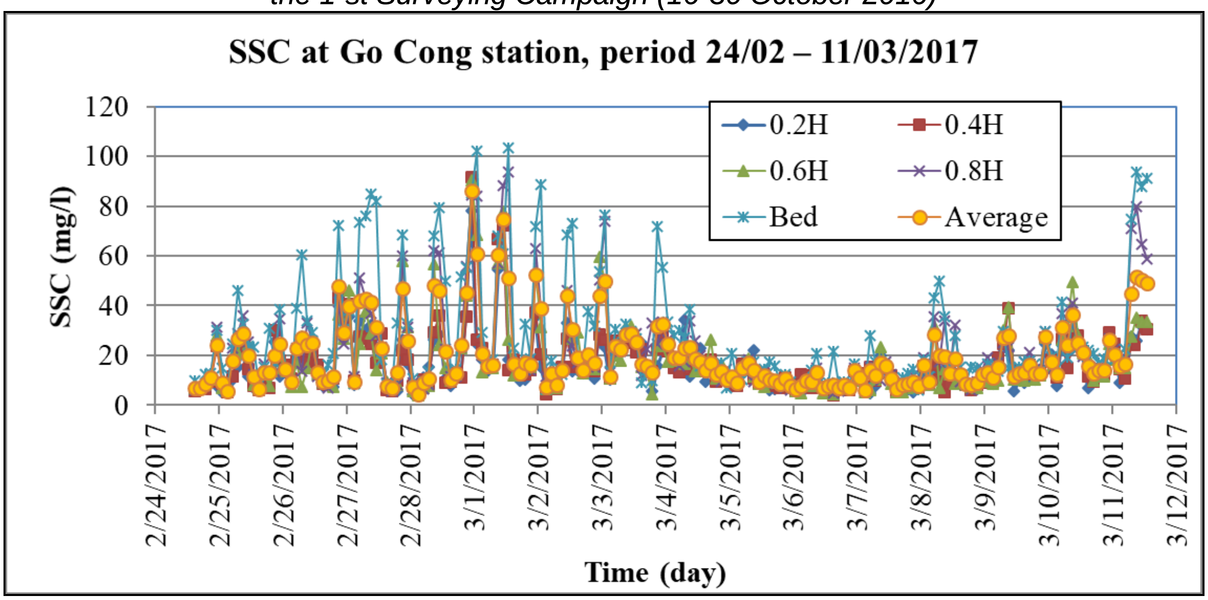

Figure 4.3: Average suspended and Bottom SSC concentrations at Go Cong observation site of the 1-st Surveying Campaign (14 Feb-15 Mar 2017)

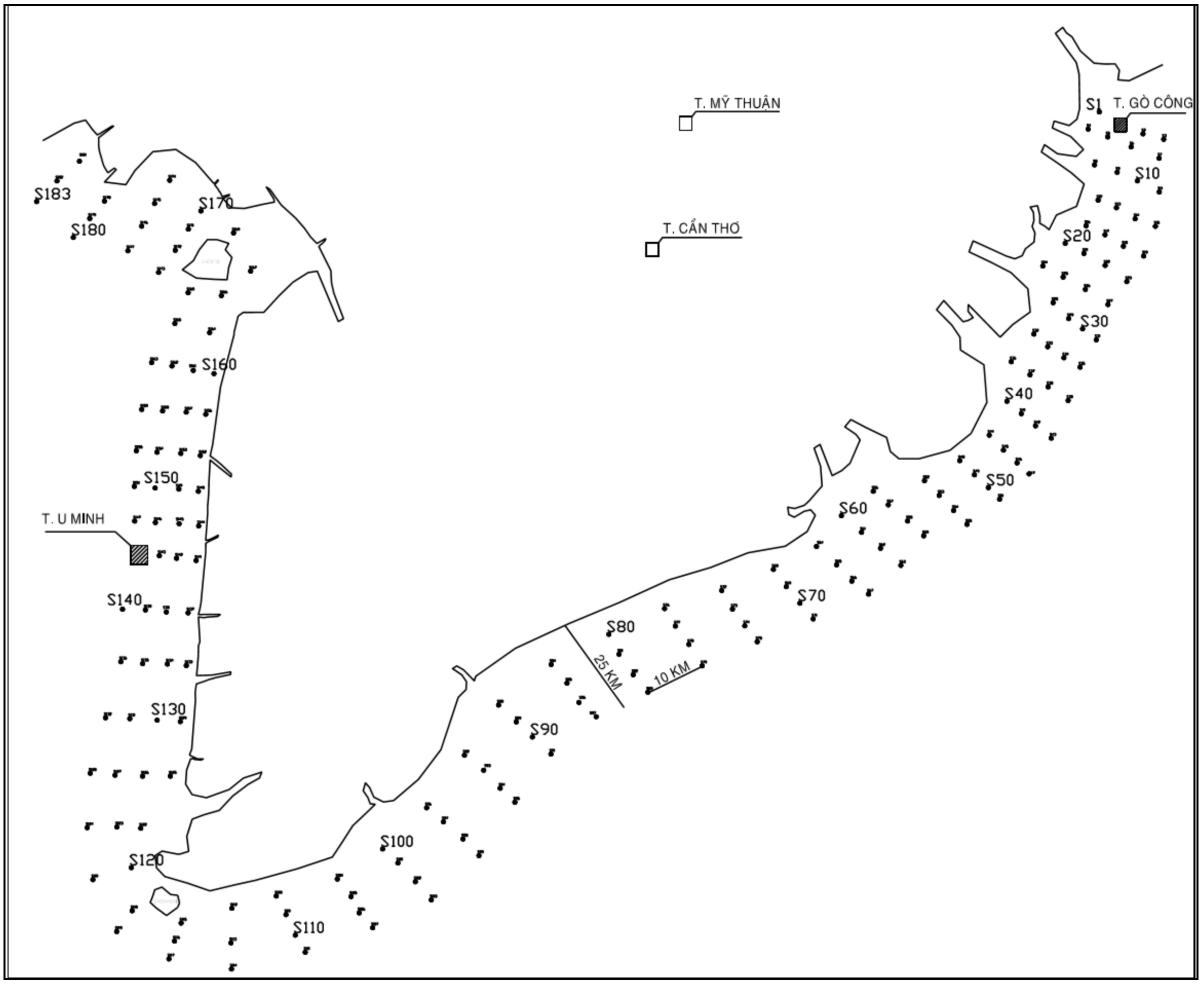

Figure 4.4: Location of 183 measure points in the East and West seas

4.2. Sediment Transport Model Calibration

In comparison with Hydrodynamic and Wave calibrations, sediment calibration is much harder due to the high uncertainty of the sediment-mud processes. Even nowadays, the determined theory describing adequately all physical phenomenon of the mud-sediment transport (especially cohesive sediment) is not built yet. This is because the present of a number of outer forces, simultaneously impacting the process. All mathematical descriptions are based mainly on empirical principles. The empirical formulas is always combined with many parameters relating to the alluvial sedimentary geology, deposition layers' thickness, grain types and sizes in deposition layers…. But observed-sampled data of this kind is strongly limited or absented at all. Therefore, these information are treated as calibration parameters. Even the sediment boundary data is built up from small discrete observed time series, so the modelers also need to calibrate to fill the gap of the data to be suited for the model use. With the mentioned above reason, the mud-sediment transport model will always latently contain potential errors.

In this context, the result of sediment model calibration of LMDCZ project (showed in figures 3.26 and 3.27) could be considered adequate for further use.

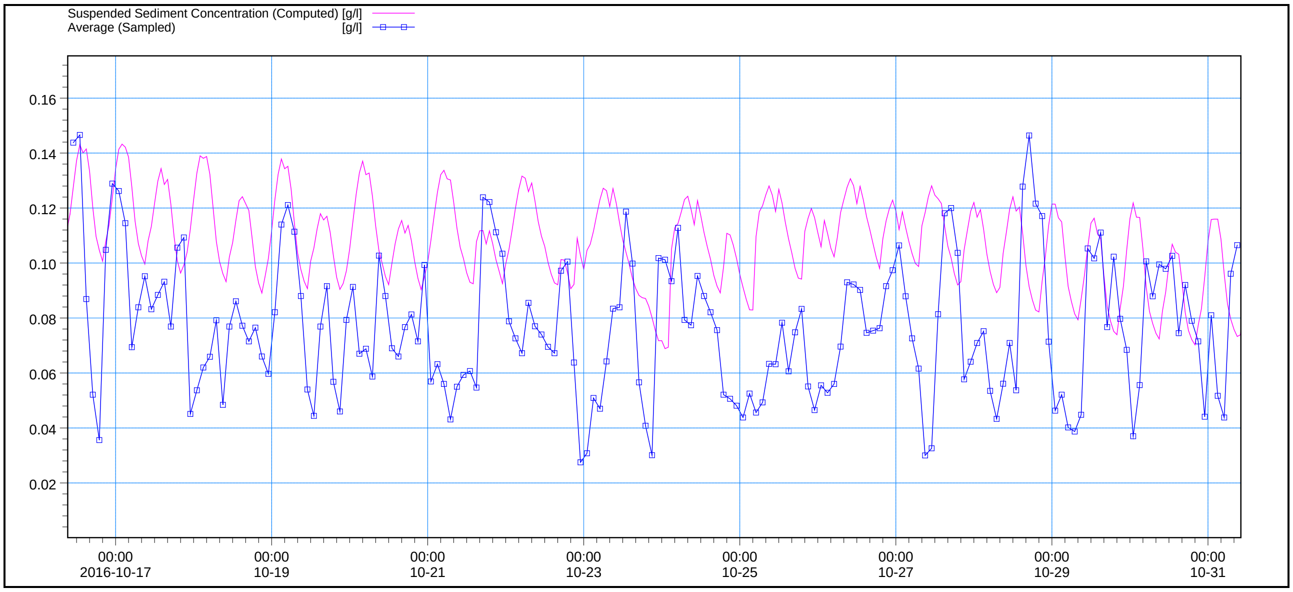

Figure 4.5: Comparison between computed and sampled suspended sediment concentrations at the Co Cong surveying location (16-31 October 2016)

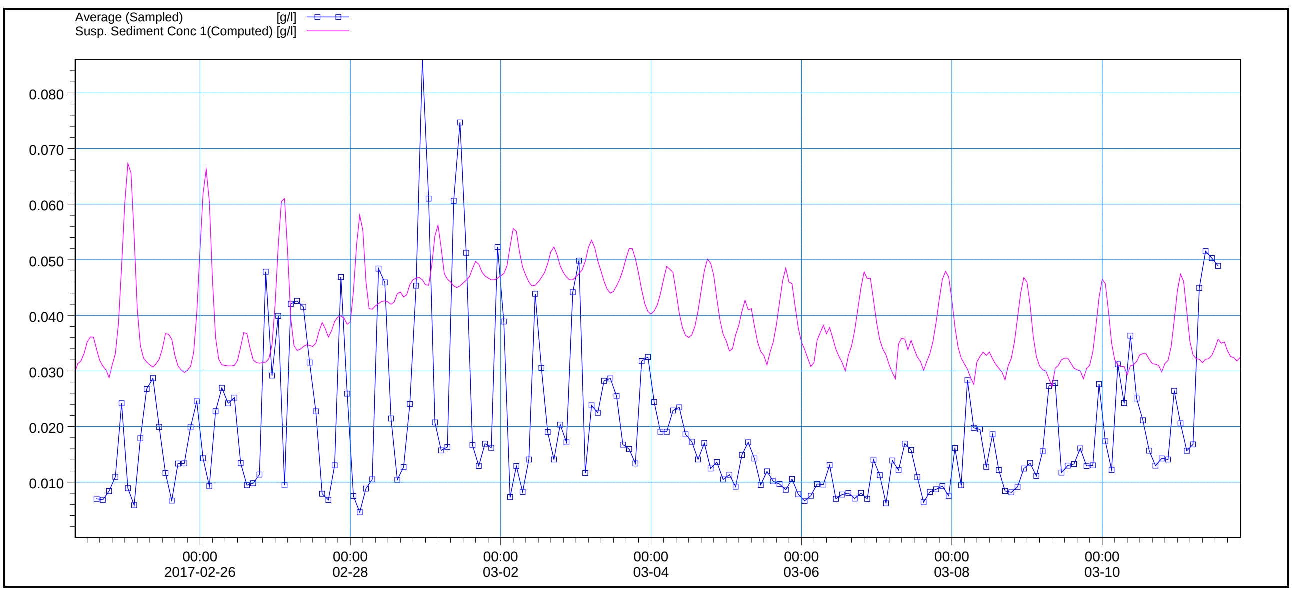

Figure 4.6: Comparison between computed and sampled suspended sediment concentrations at the Co Cong surveying location (24 Feb-12 Mar October 2017)

Calibration/validation results Figure 4-2 to Figure 4-4 expressed the comparison of SSC simulated and observed data in 2009 and in 2012 at Mekong estuaries and Saigon-Dong Nai estuaries. Figure 4-7 to Figure 4-9 presented comparison of SSC distribution in the coastal area between the analysis results and the satellite images of the Kalicotier project at different times in Southwest monsoon (26/7/2009) and Northeast monsoon (06/12/2009 and 24/02/2010). Figure 4-5 and Figure 4-6 compared SSC in the SW monsoon (October 2016) and NE monsoon (Feb.-Mar. 2017) at Go Cong and U Minh stations (about 15 km offshore). It can be seen the good simulation for seasonal sediment transport.

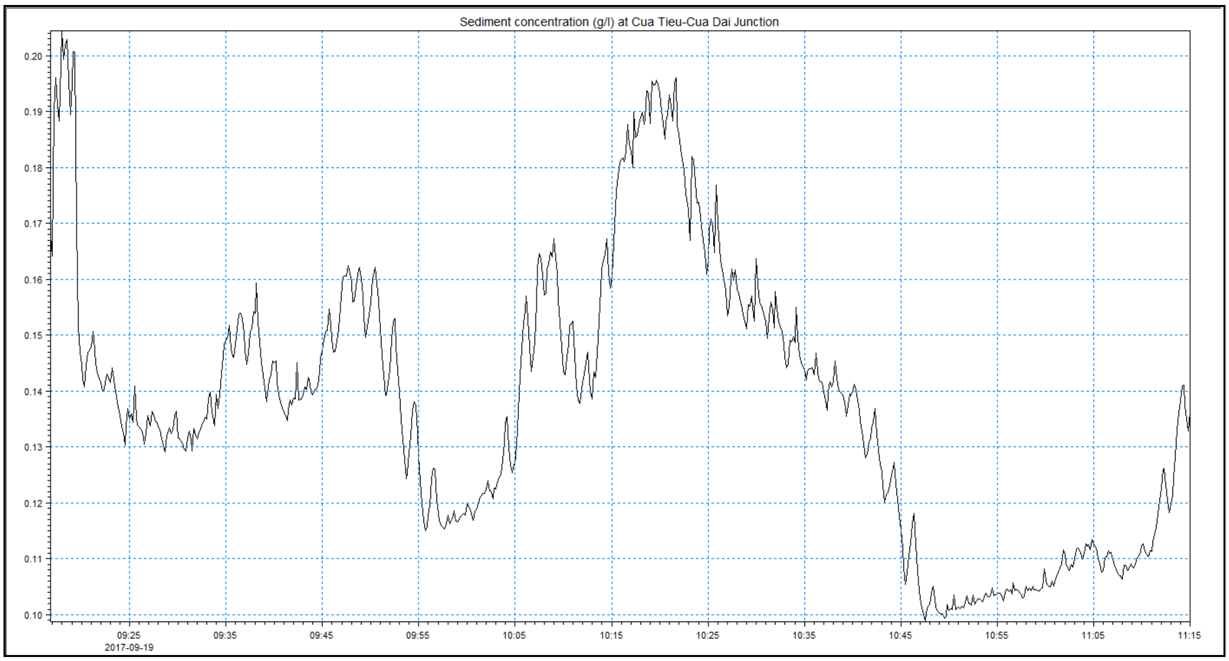

Figure 4.7: Sediment concentration over time at the CuaTieu-Cua Dai Junction in September 2014 before structure building (unit: g/l)

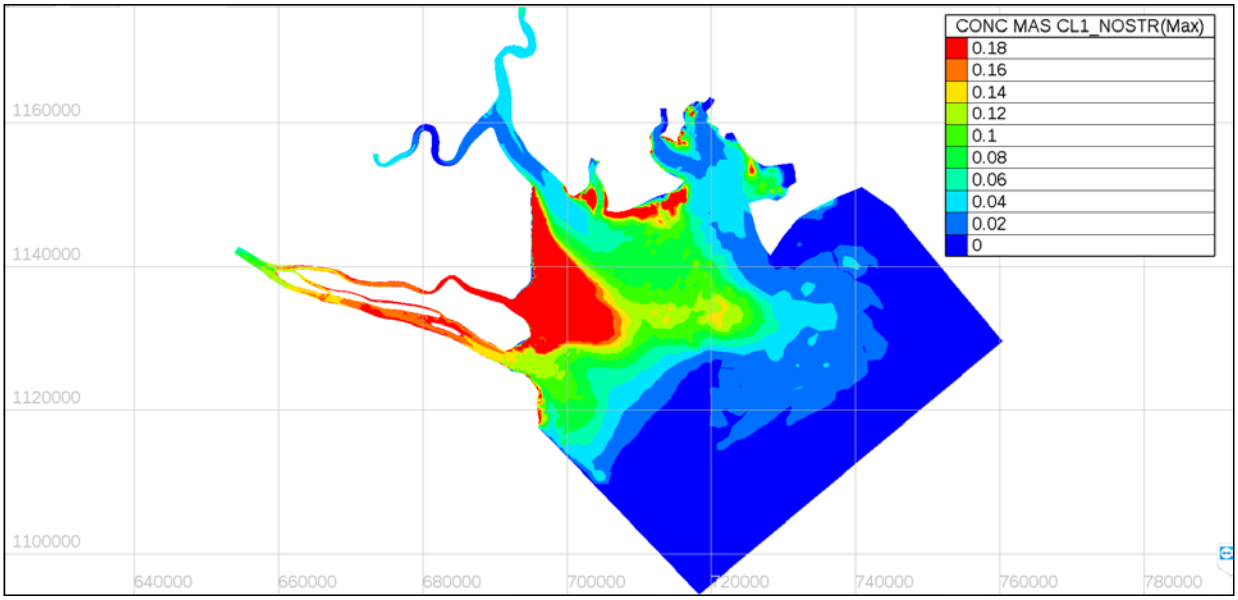

Figure 4.8: Maximal sediment concentration (g/l) in January 2014

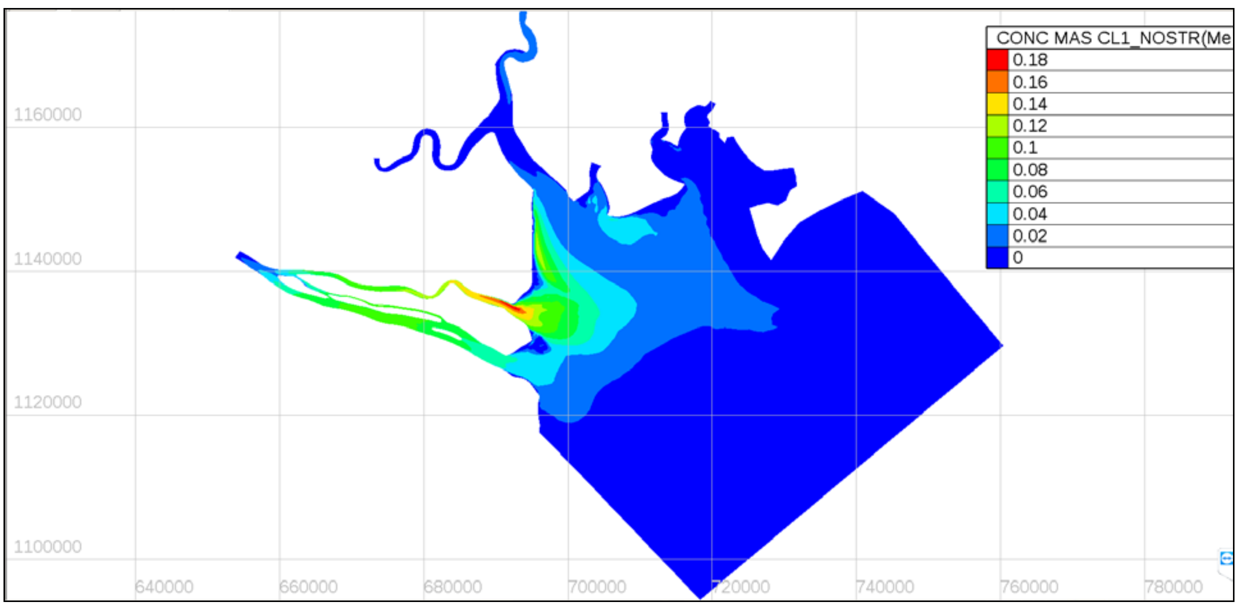

Figure 4.9: Mean sediment concentration (g/l) in January 2014

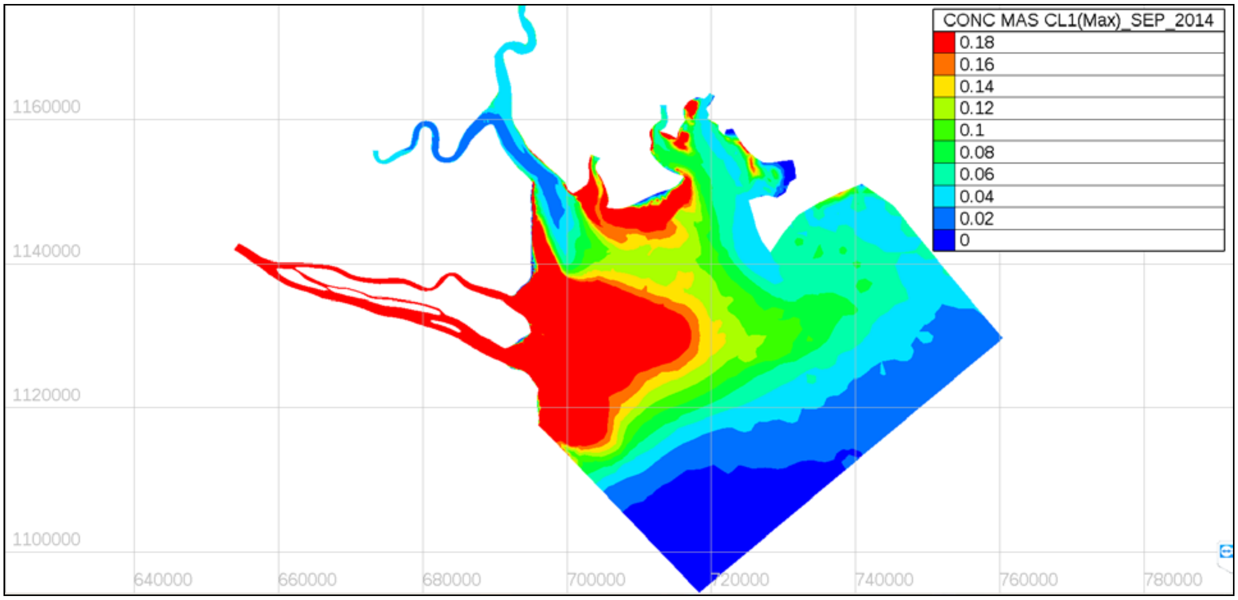

Figure 4.10: Maximal sediment concentration (g/l) in September 2014

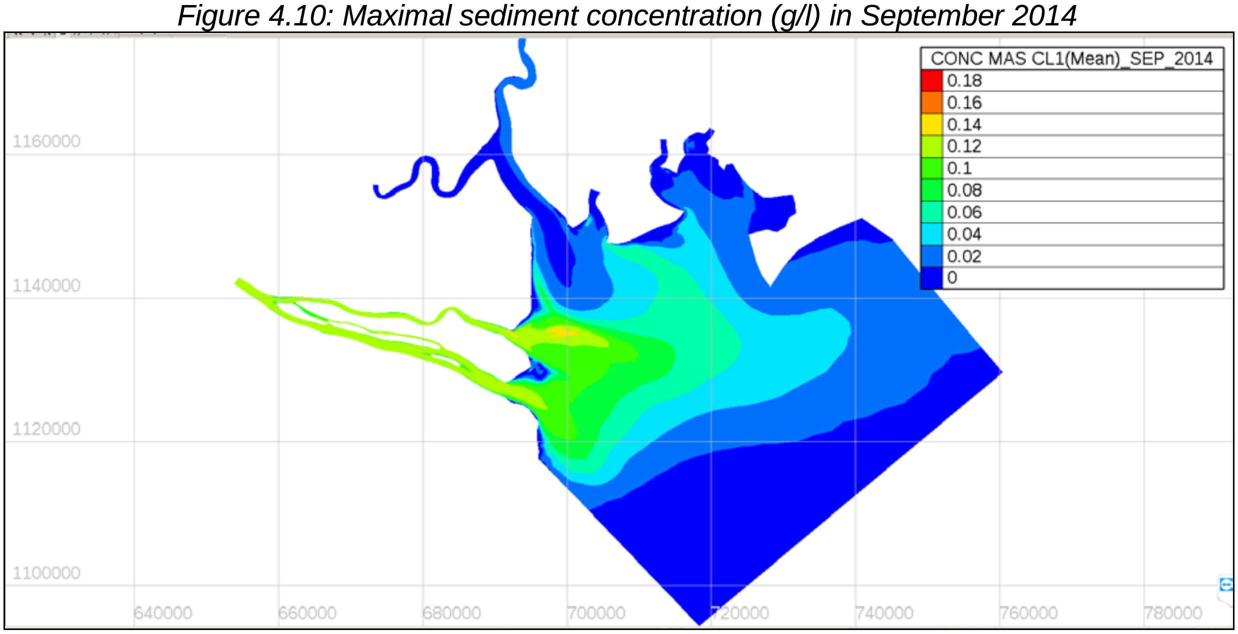

Figure 4.11: Mean sediment concentration (g/l) in September 2014

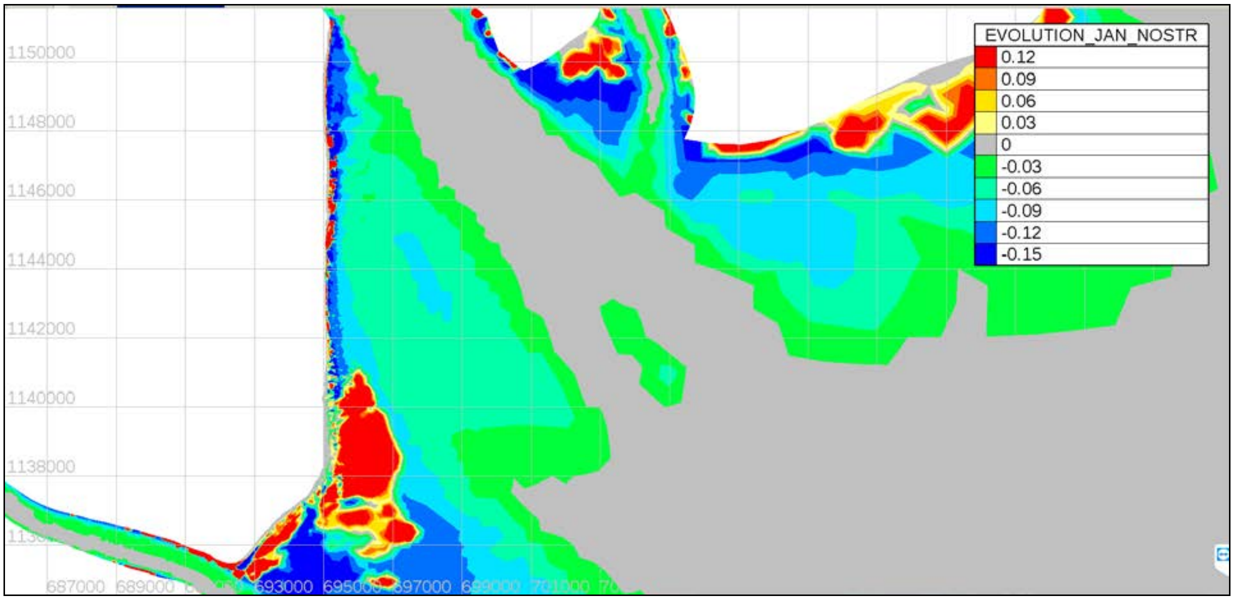

Figure 4.12: Go-Cong Coastal zone's bed evolution (m) in January 2014

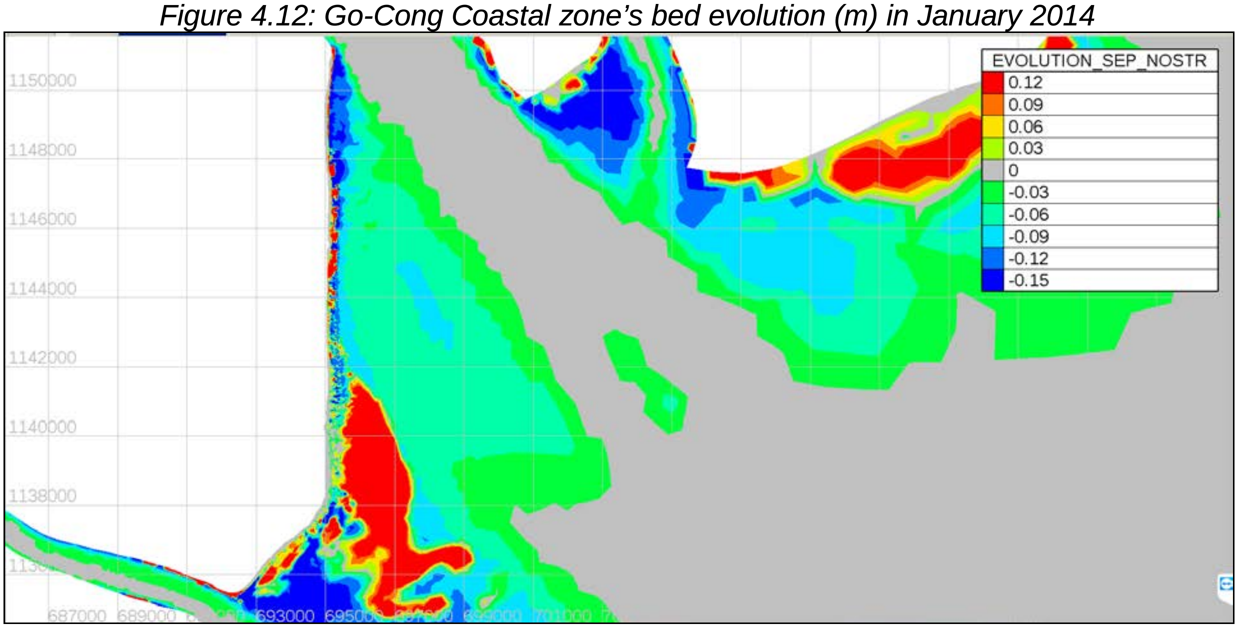

Figure 4.13: Go-Cong Coastal zone's bed evolution (m) in January 2014

5. CONCLUSION

With nesting approach, Telemac2d-Tomawac-Sisyphe has been calibrated well from the Regional model to Local Model with water levels, discharges, tides, waves and currents, sediment transports especially the validation results based on the in-situ data of the LMDCZ project in October 2016 and February-March 2017. These results in the Local model of LMDCZ are ready for creating the boundary conditions for the detail study areas of Go Cong and Phu Tan.