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Suspended sediment transport in Red River Delta coastal area

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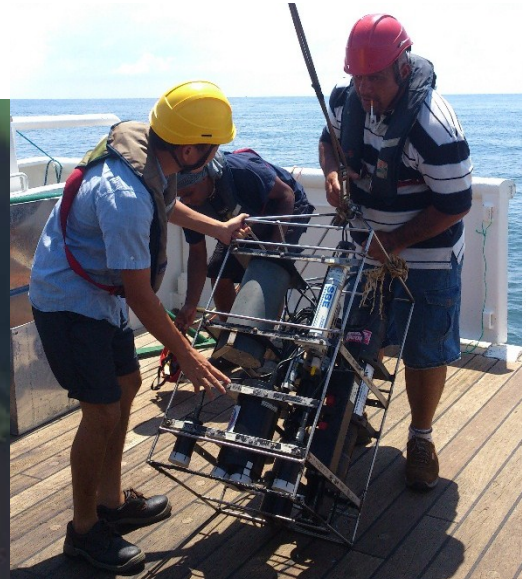
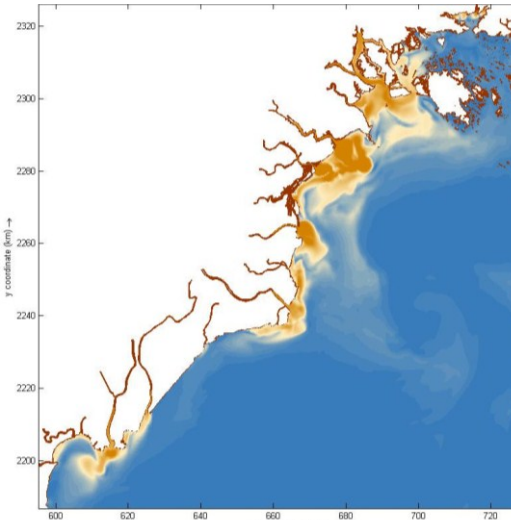




Introduction

Red River

Wind NE

Max amp. ~4.0m

Diurnal tide

wave

Wind SW

Introduction

Red River

Hai Phong port

Do Son beach

Deposition

Water turbidity

Wind NE

Max amp. ~4.0m

Complicated hydrodynamics, sediment transport

Diurnal tide

Hai Hau

Erosion

wave

Wind SW

Deposition in HP ports

- Dredging about 3.8 million ton/year, expenditure 70-80 billion VND for dredging (3.3-3.7 million US$)
- Trend: mud deposit rate in the estuary is increasing

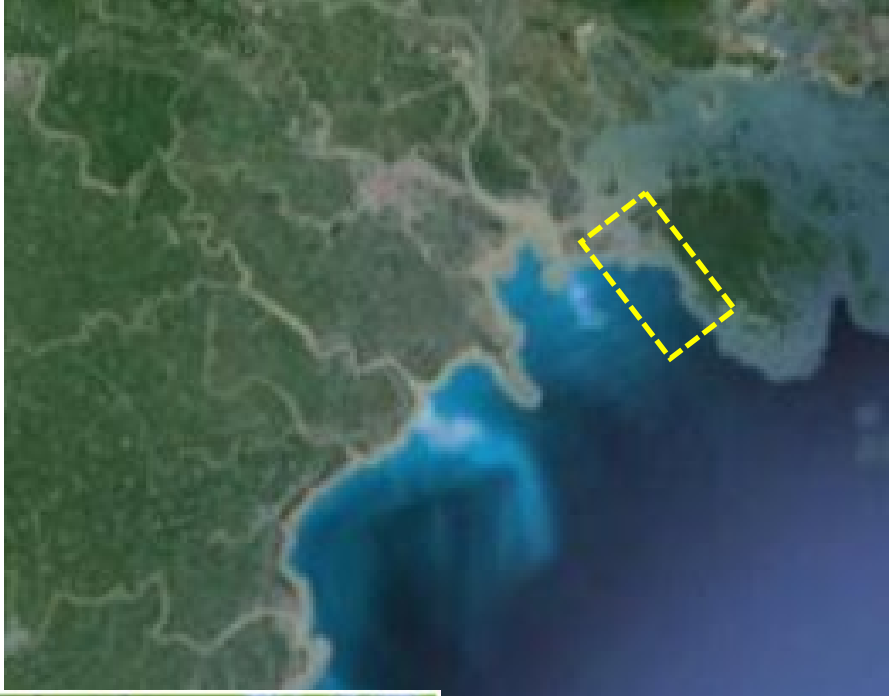
Source: Vinh et al, 2014 Hydrology & Earth System Sciences (IF=3.6)

Deposition in HP ports

- Dredging about 3.8 million ton/year, expenditure 70-80 billion VND for dredging (3.3-3.7 million US$)
- Trend: mud deposit rate in the estuary is increasing

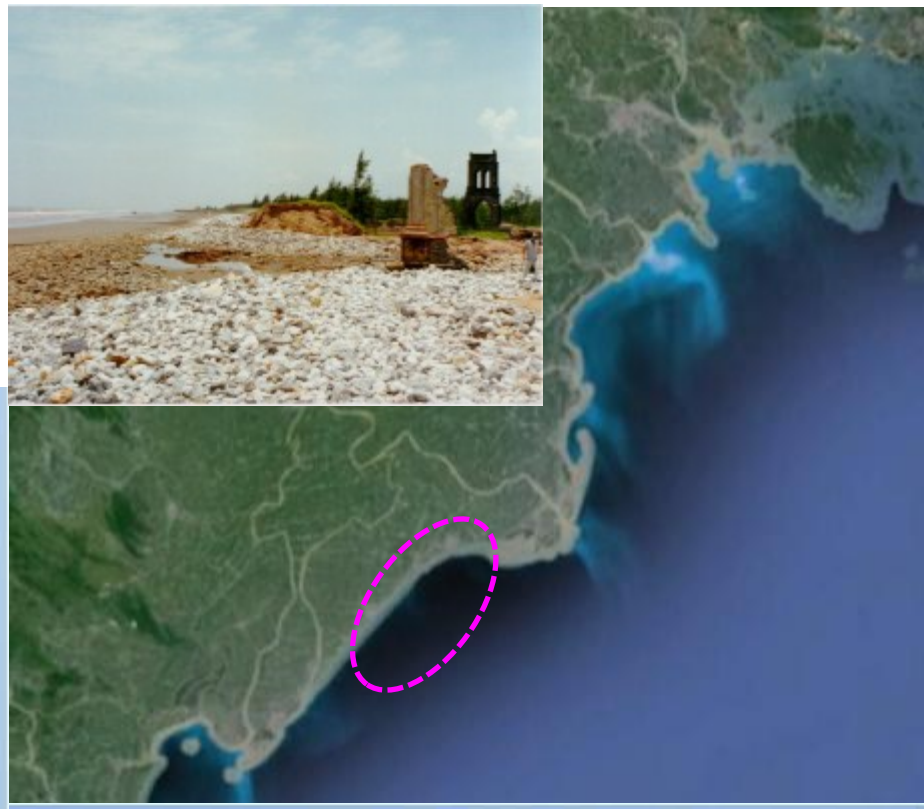
→ New harbor offshore

Cost: 2 billion US$



Erosion in Hai Hau

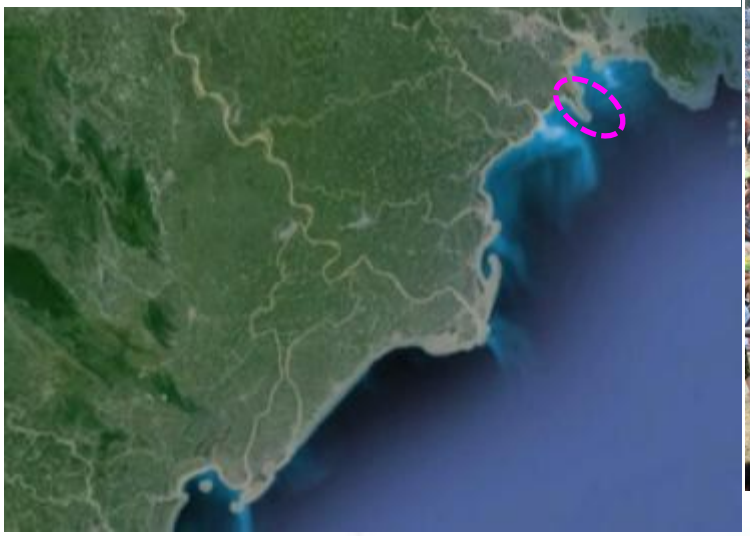
- Erosion extending over a length of 30 km, with average rate of 10 -15 m/year, maximum 20 - 30 m/year, taking away 10ha/year
- At present 1/4 of the coastline of the Red river delta is being eroded.



Source: Vinh et al, 2014 Hydrology & Earth System Sciences

Turbidity in Do Son beach

- About 2 million visitors/year



Introduction

Red River

Deposition

Water turbidity

Wind NE

Max amp. ~4.0m

What about processes of hydrodynamics and suspended sediment transport in the RRD coastal area?

Diurnal tide

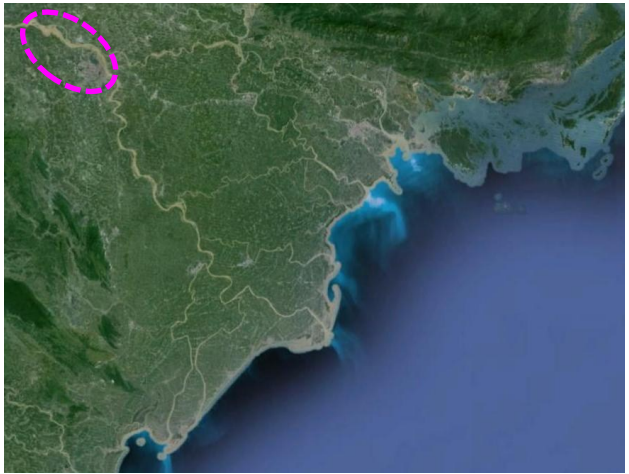
wave

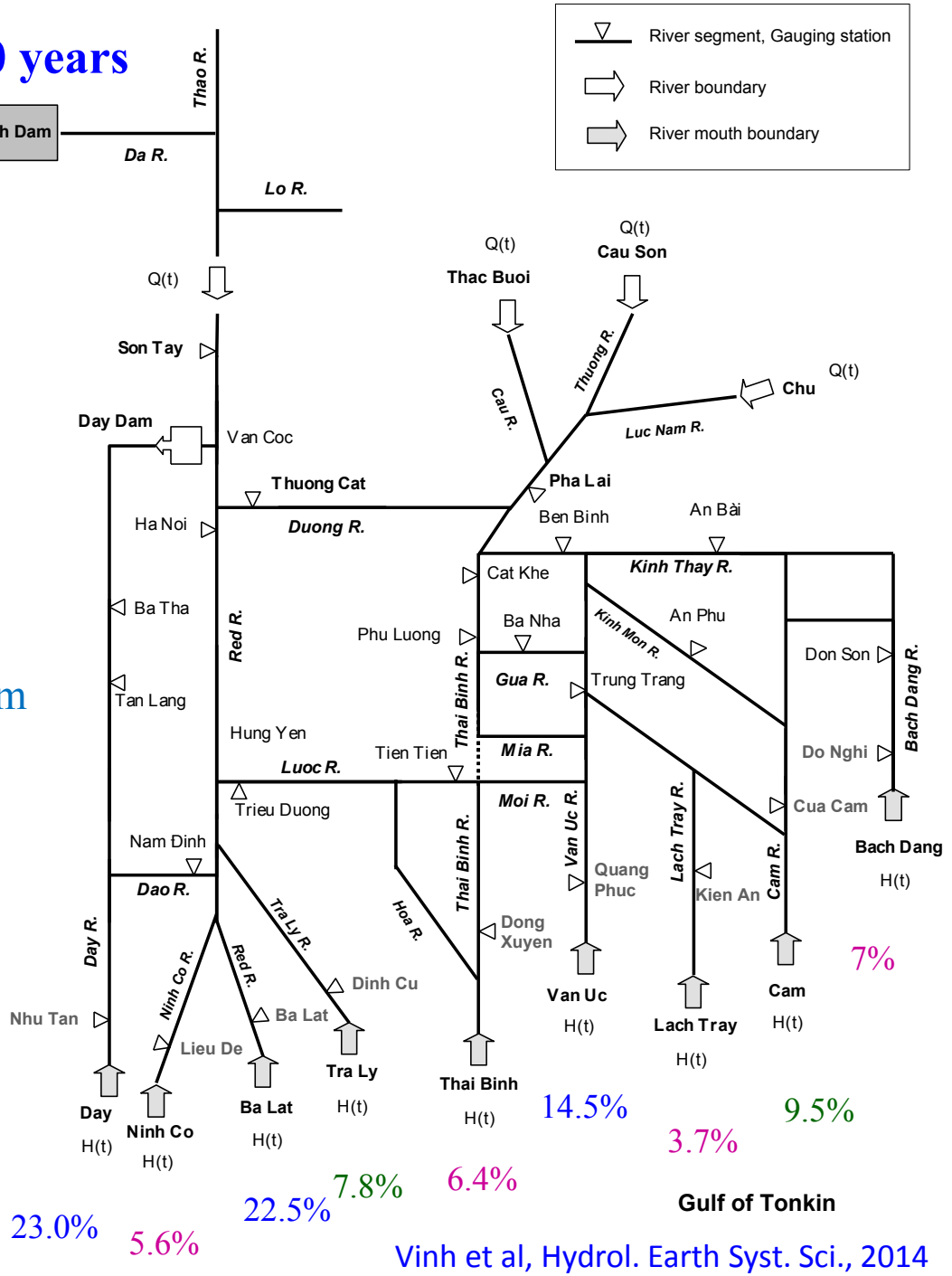
Erosion

Wind SW

Variation of sediment discharge in 50 years 1960-2010

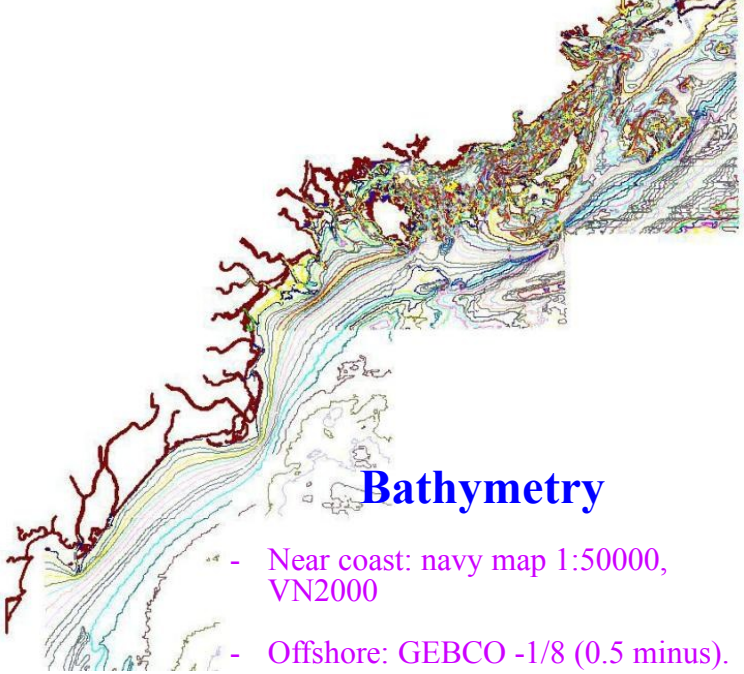
- Water: 80.5-161 10^9 m3/year
  rainy: 71-79 %
- Susp. Sed.: 10.4-200.9 mil. tons.
  rainy: 70-96%
- Strong impact of Hoa Binh Dam
  - decreased 61% sediment after HB dam





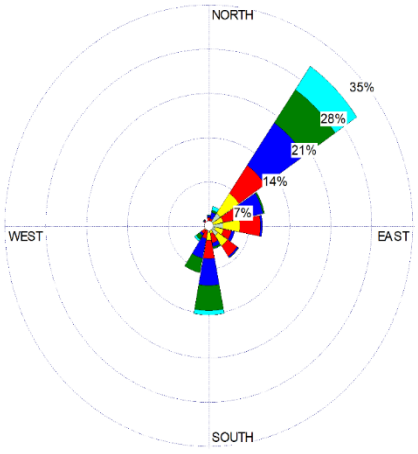
Vinh et al, Hydrol. Earth Syst. Sci., 2014

Data

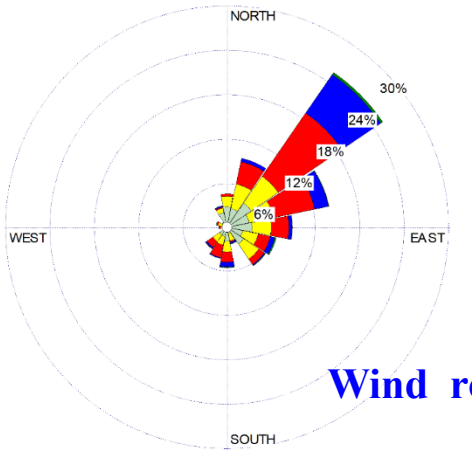


Bathymetry

- Near coast: navy map 1:50000, VN2000
- Offshore: GEBCO -1/8 (0.5 minus).



Bach Long Vy 2014



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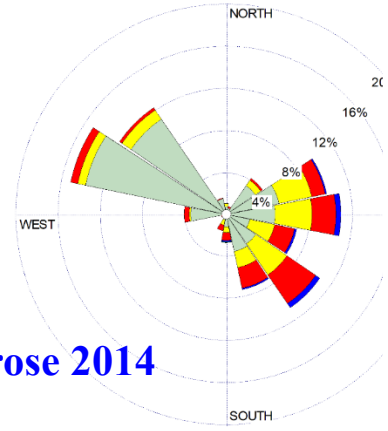
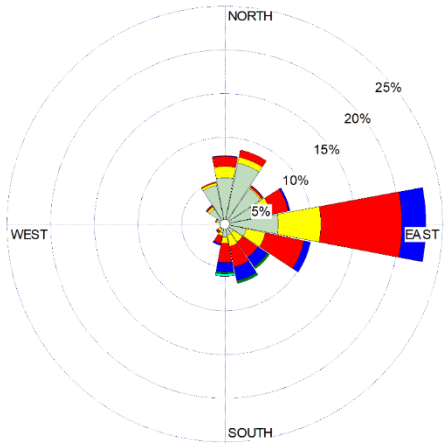
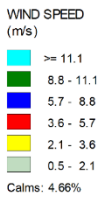


Sam Son

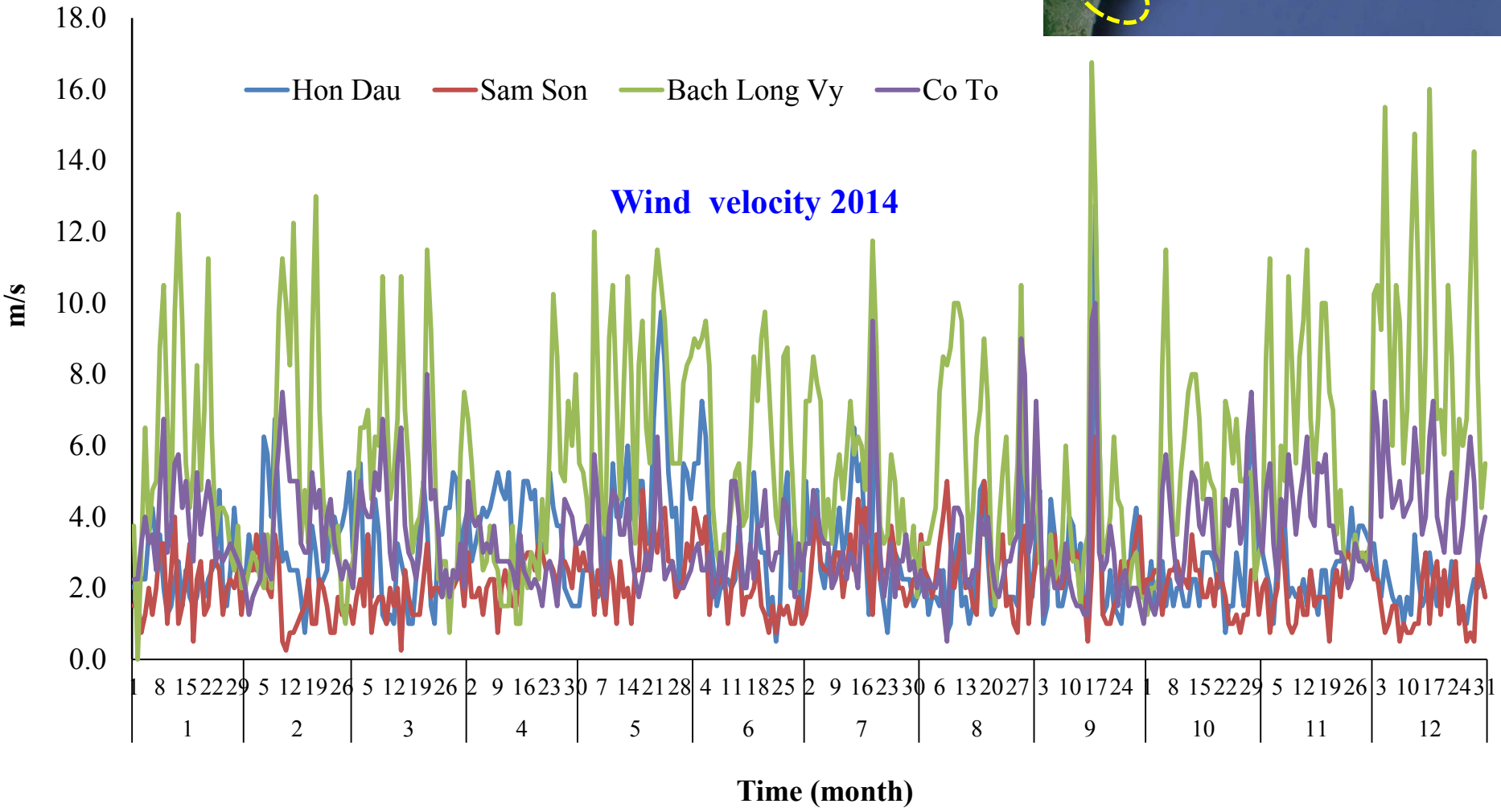


Hon Dau

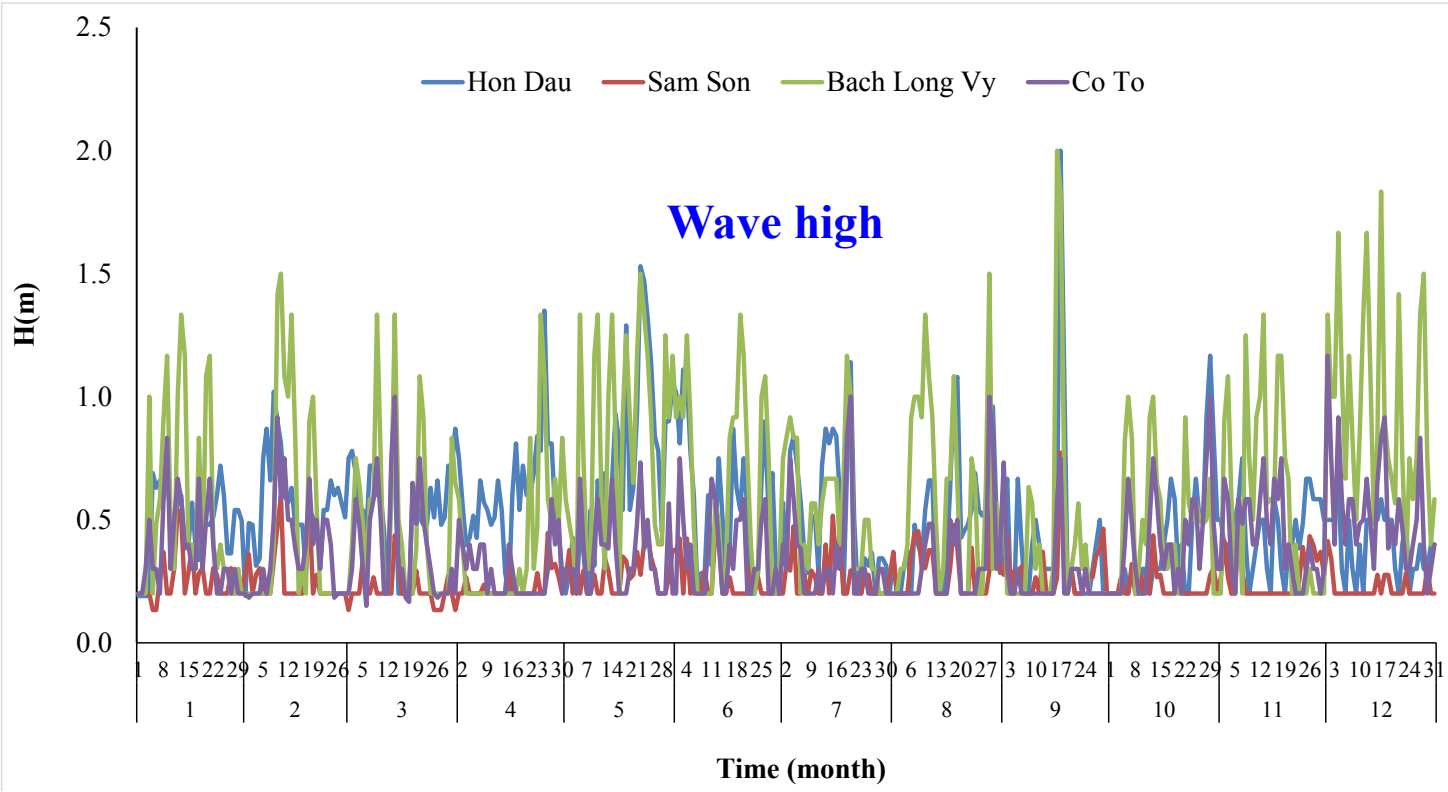
Wind rose 2014

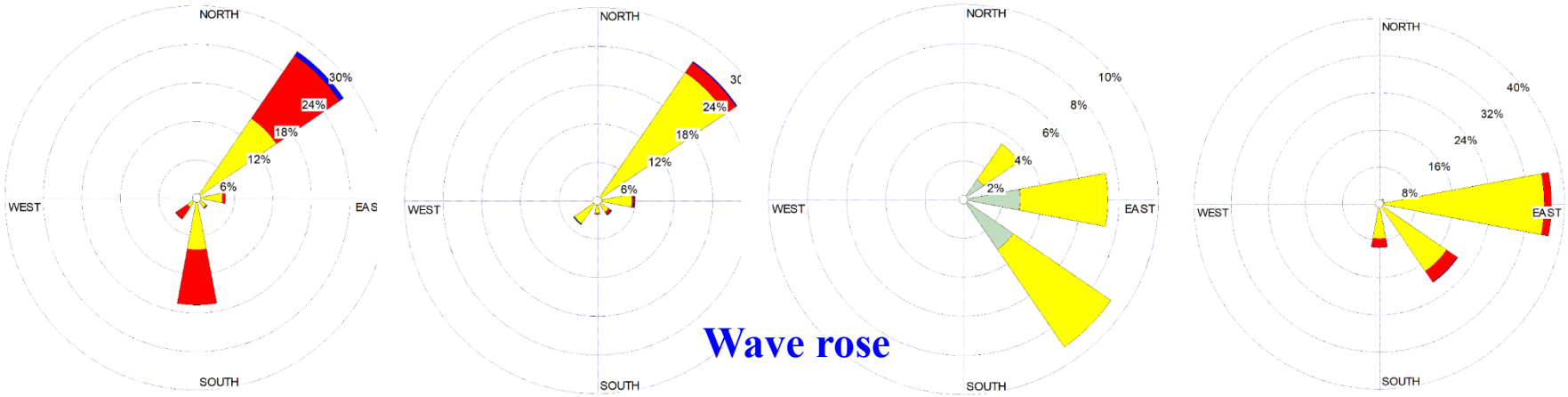


Variation of wind velocity



Wave data in 2014





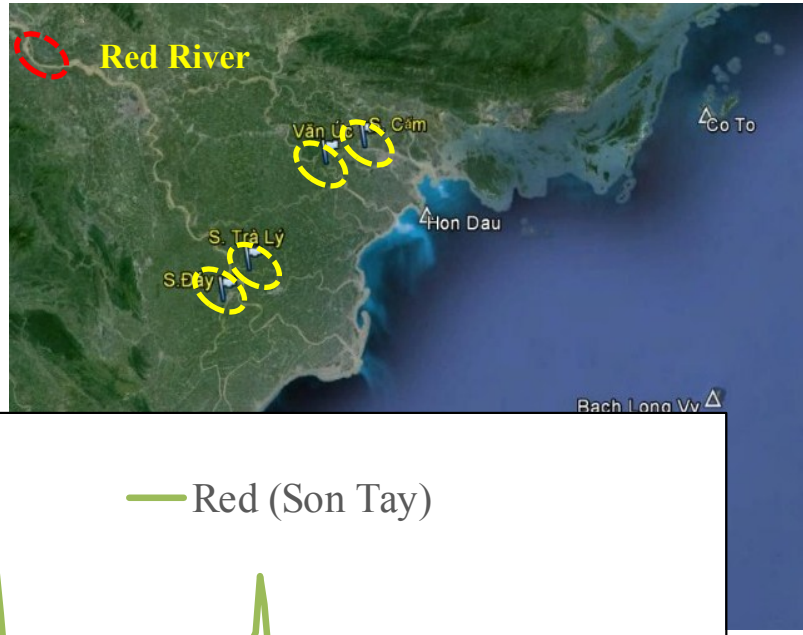
Bach Long Vy 2014

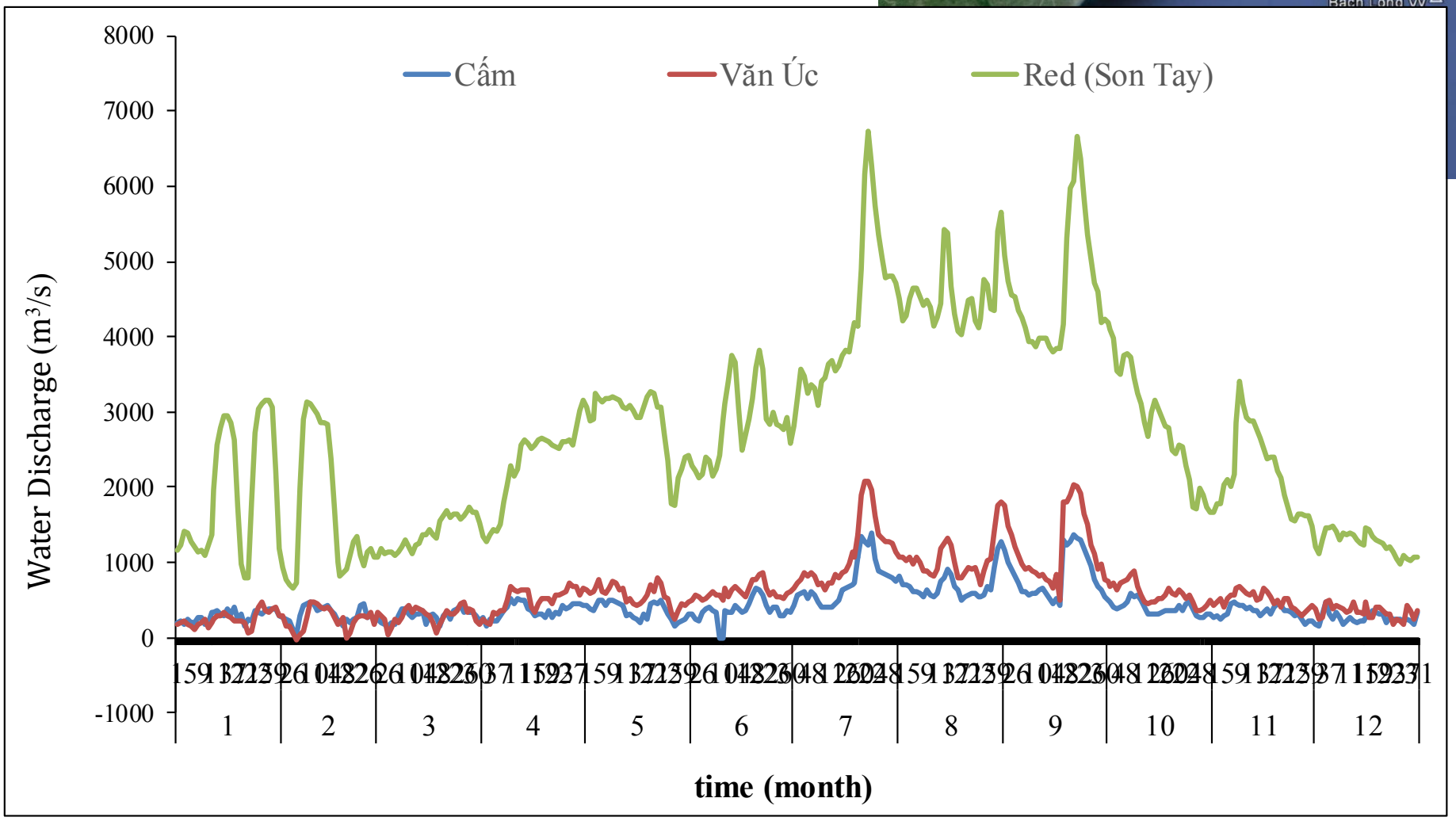
Co To

Sam Son

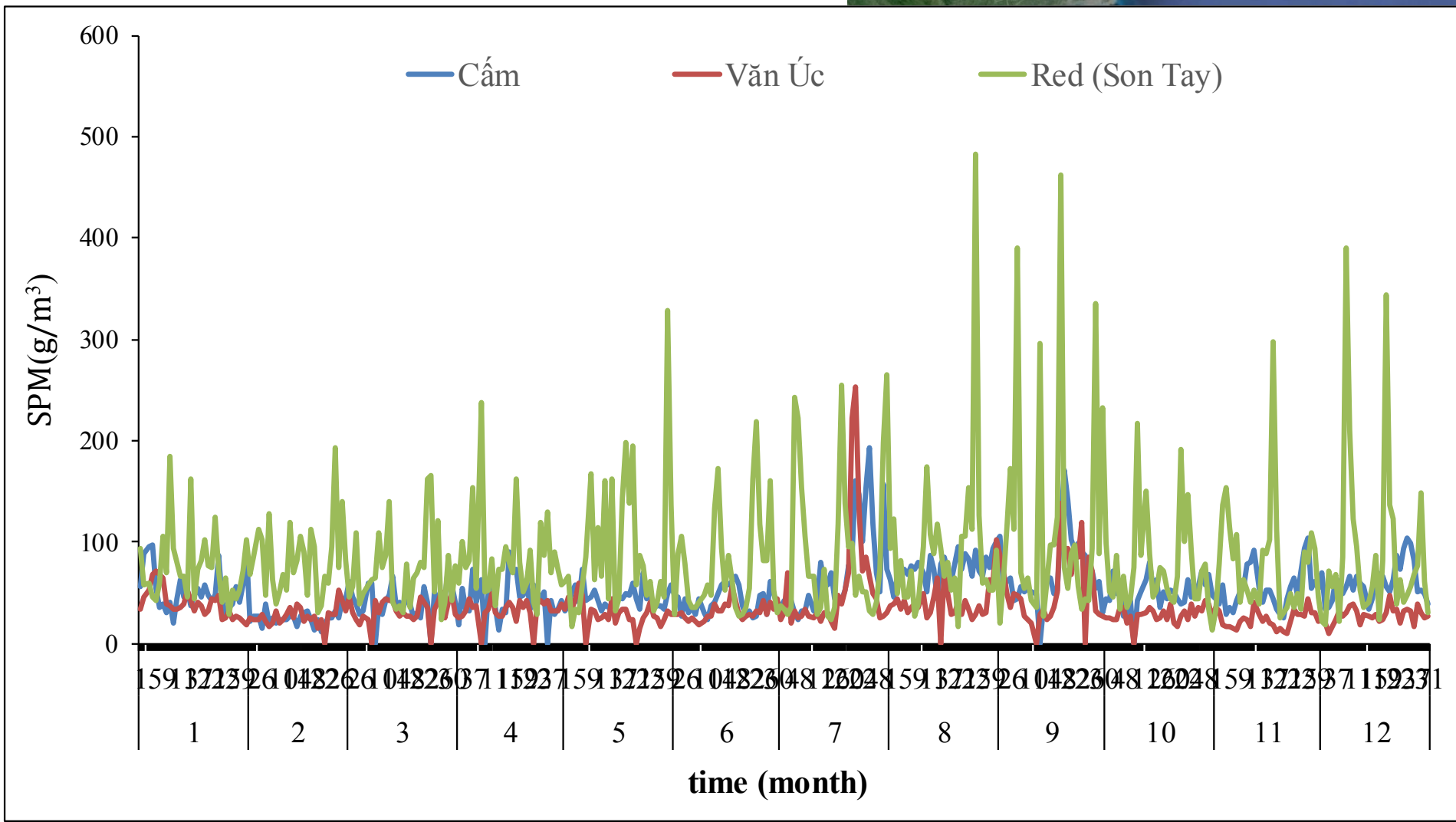
Hon Dau

River water discharge in 2014

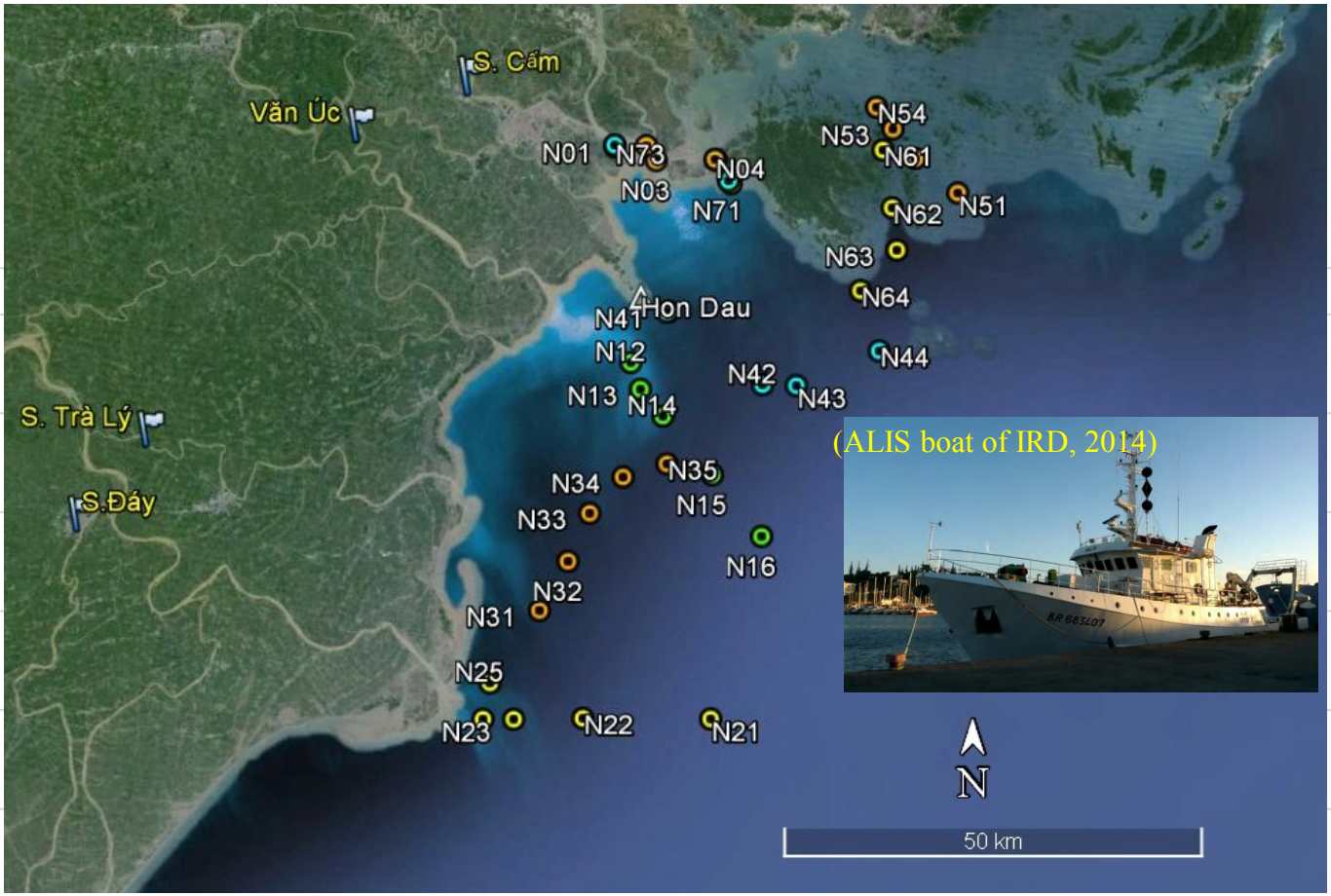


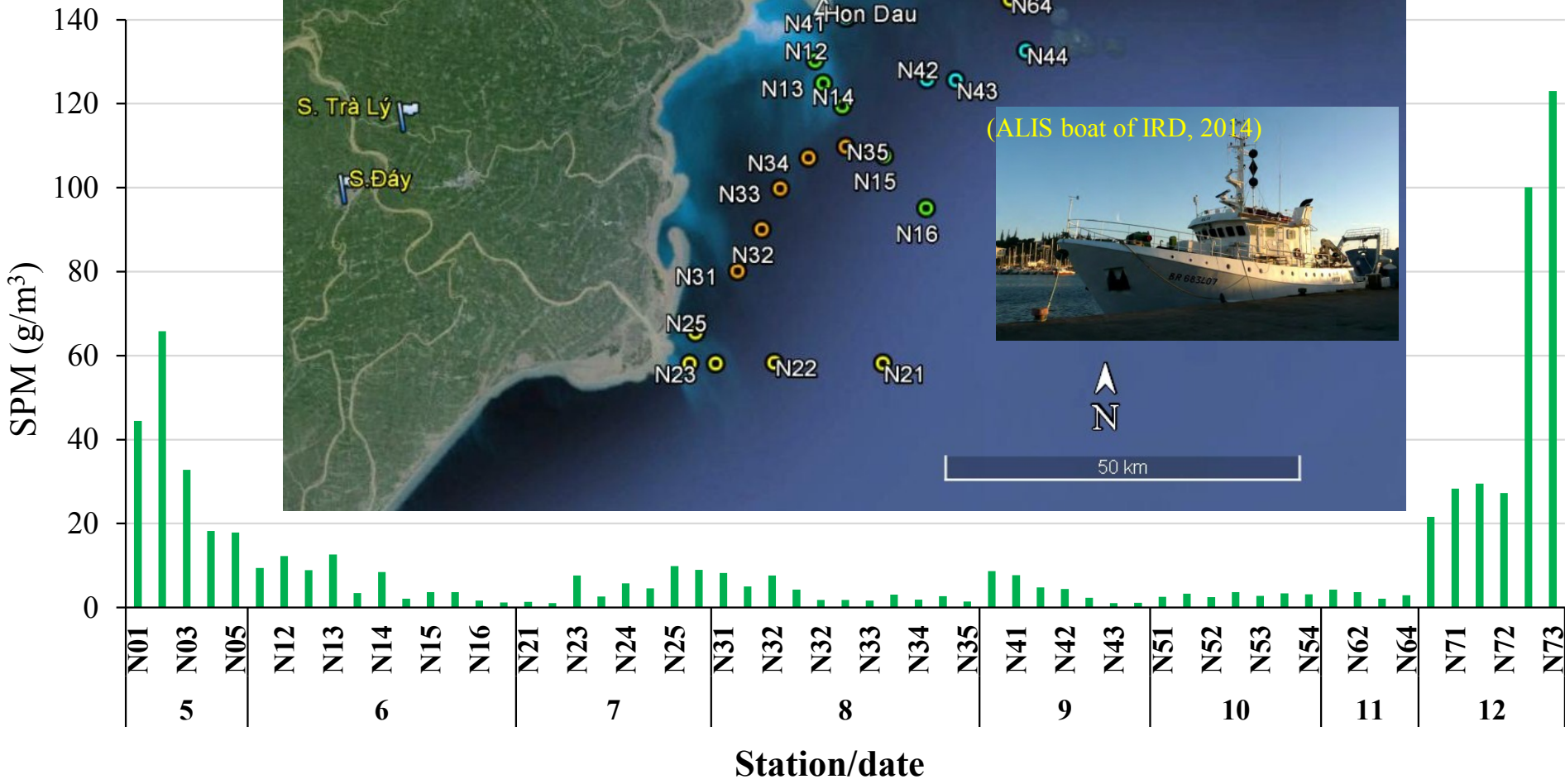


SPM concentration in the river



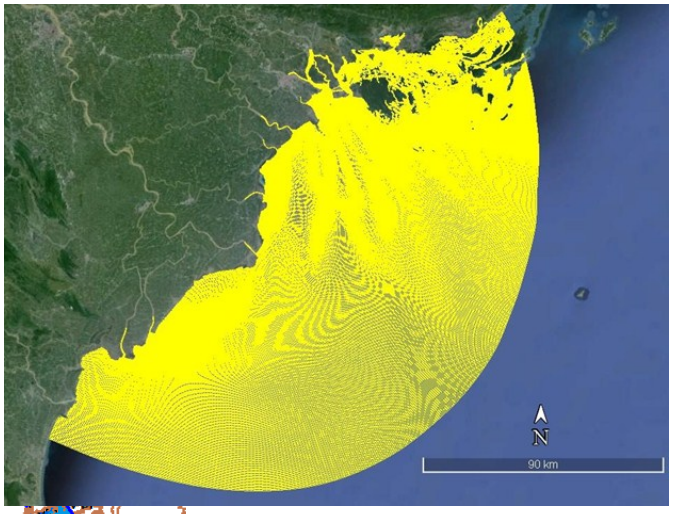
SPM concentration in the coastal area (ALIS boat: 5-12/7/2014)



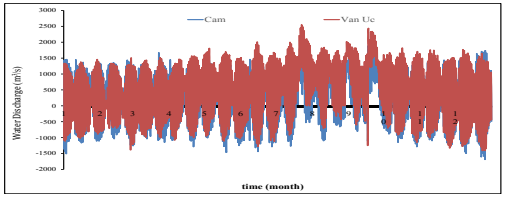


Model setup

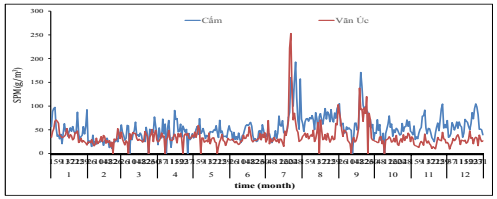
- Orthogonal curvilinear gird
- (m,n)=608 x 605, Δxy=9.3-1800.39m
- wet/dry scheme
- σ coordinate system in vertical: 5 layers
- Coupling online: hydrodynamics-wave- sediment



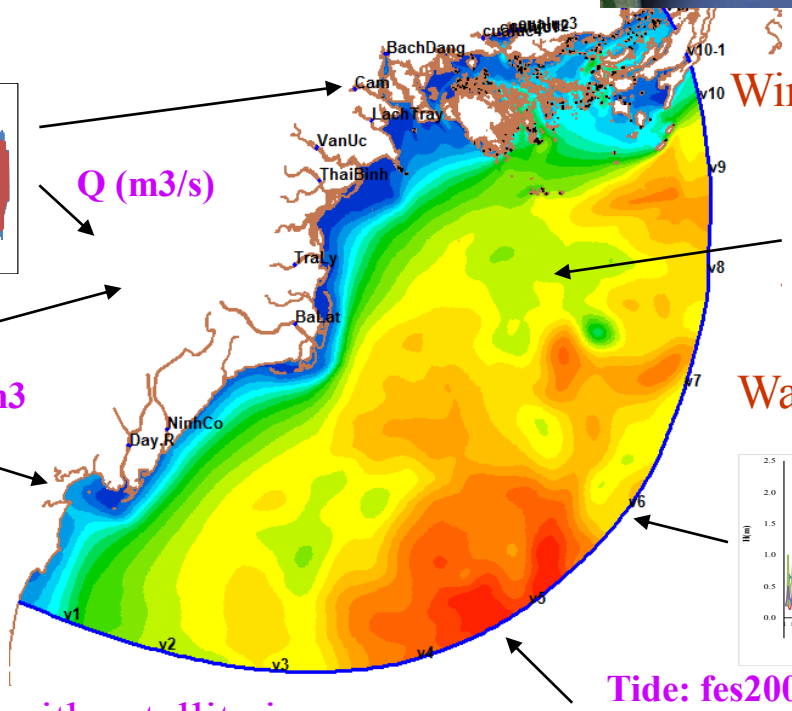
River boundary condition:



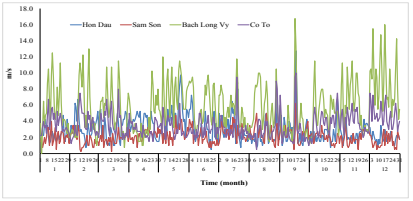
Q (m3/s)



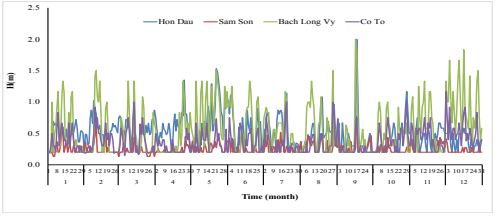
C (g/m3



Wind: time serial in 2014



Wave: time serial in 2014



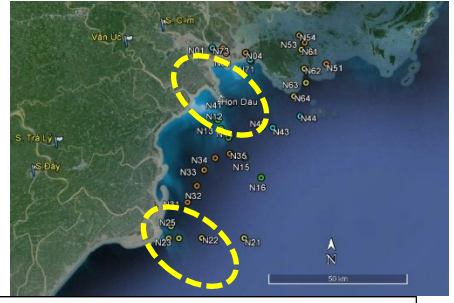
Tide: fes2004

Salinity, Temperature: WOA13

Scenarios:

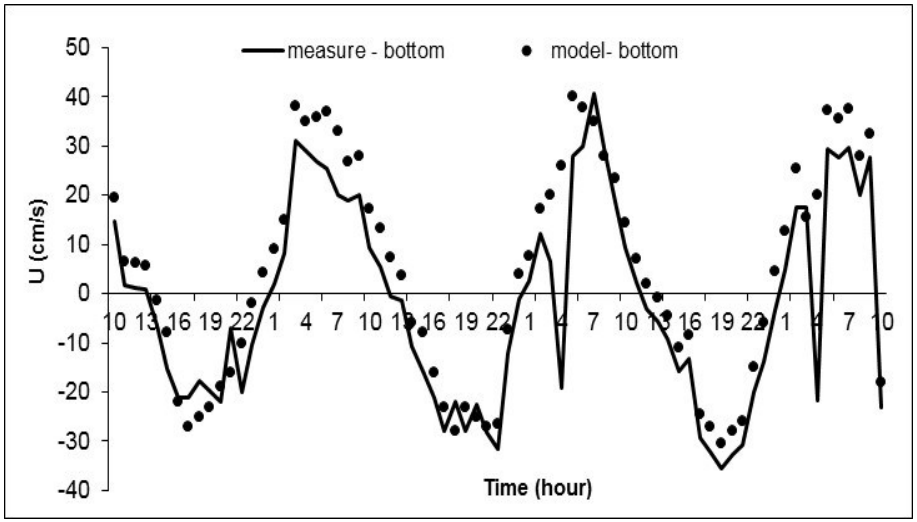
- Jun., Sep., Dec. : validation with satellite image
- July 2014: validation data from the ALIS boat
- May, Sep., 2015: validation with VIETNAMINS data (ongoing)

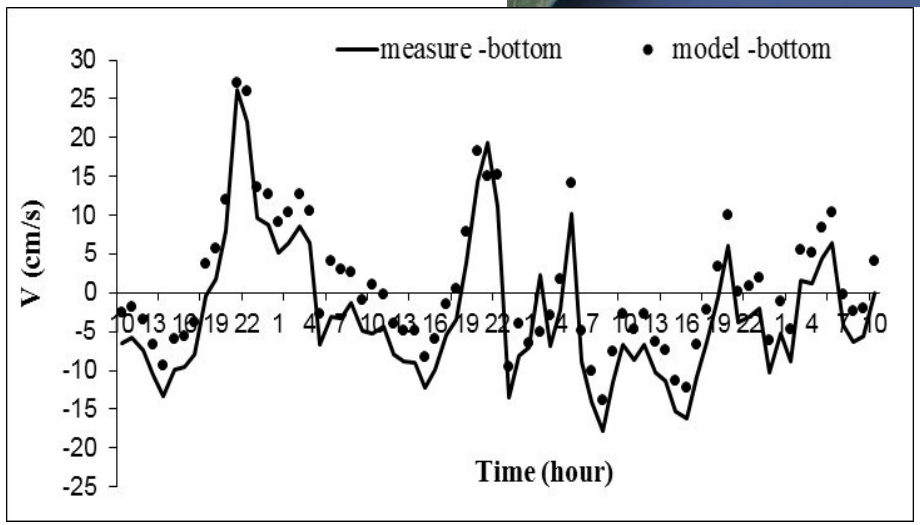
Model validation with measured current data



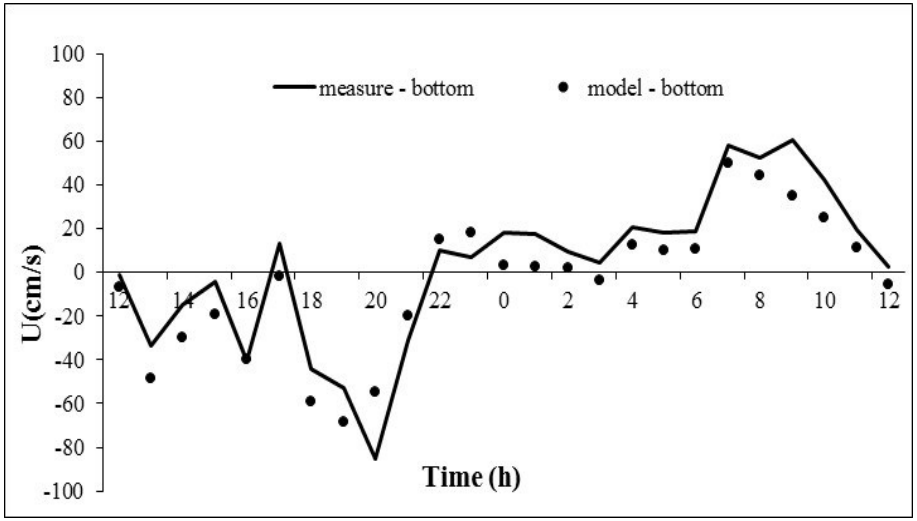
R= 0.87-0.92, E= 76-84%

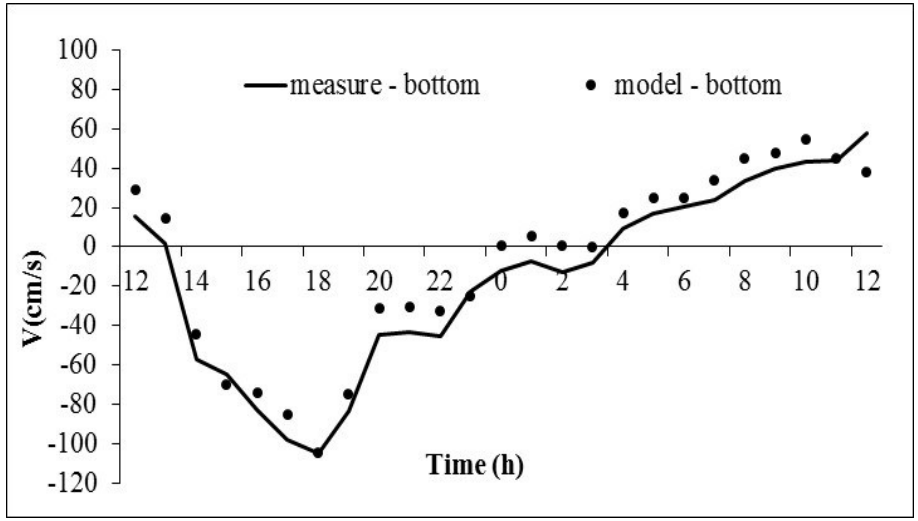
Nam Trieu



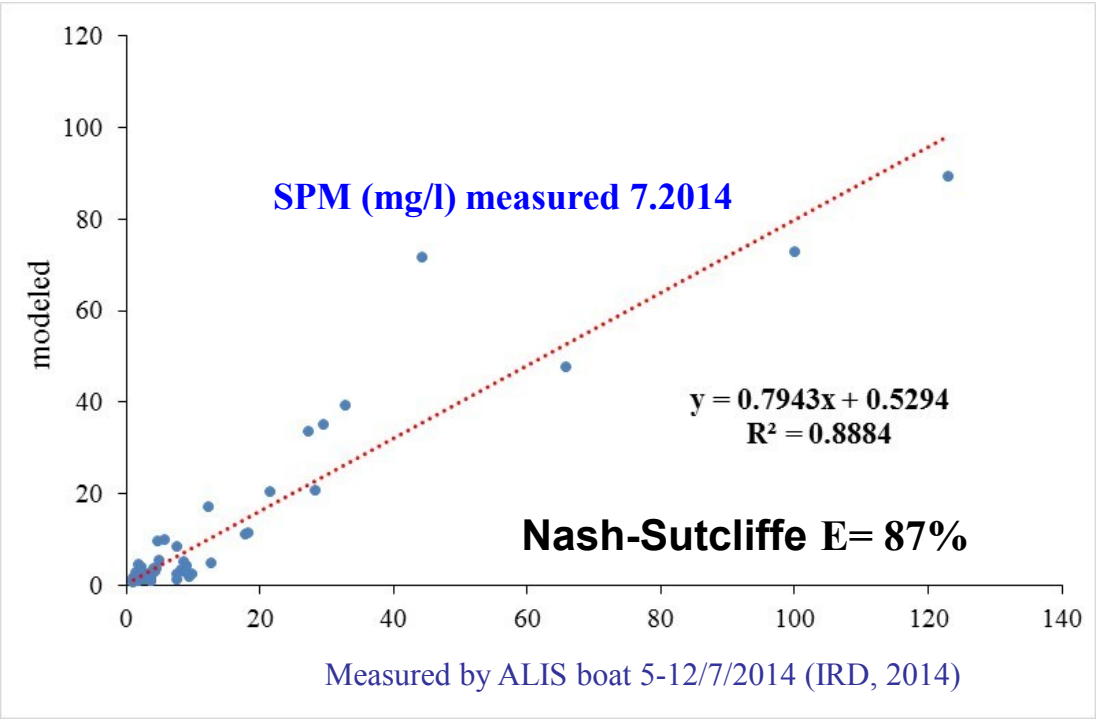


Ba Lat

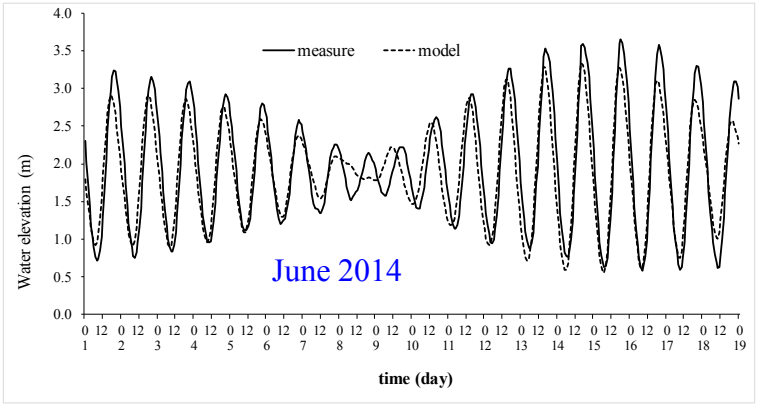


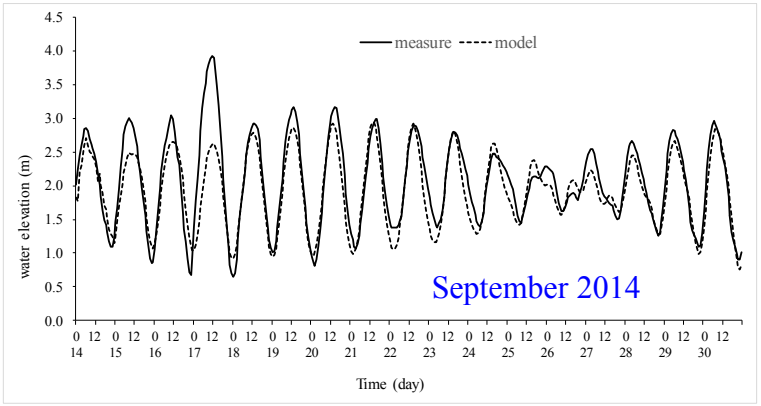


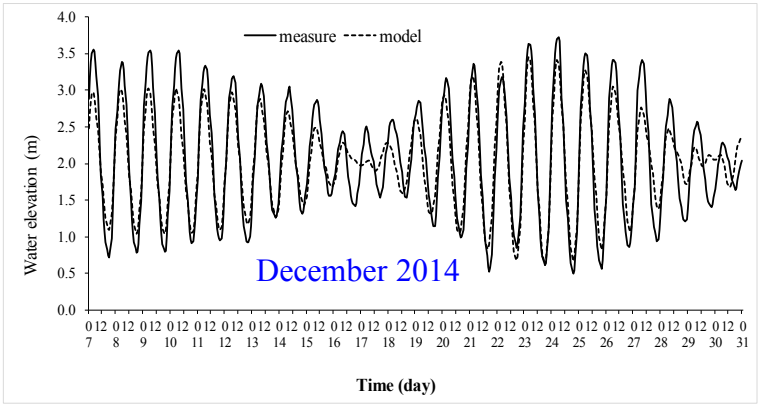
Model validation with measured data



Measured by ALIS boat 5-12/7/2014 (IRD, 2014)

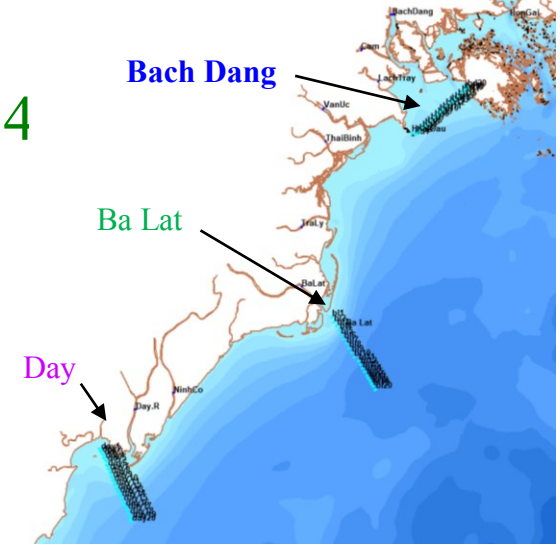


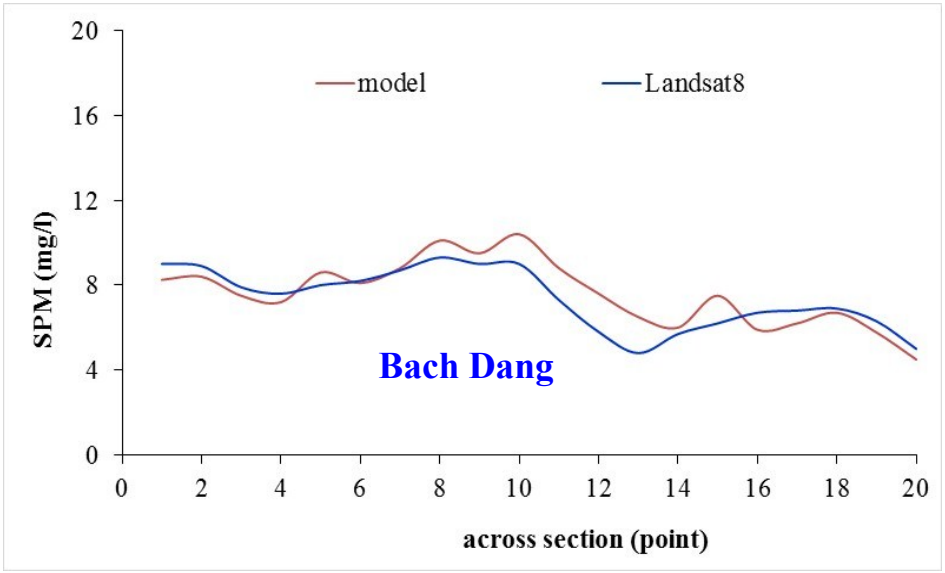


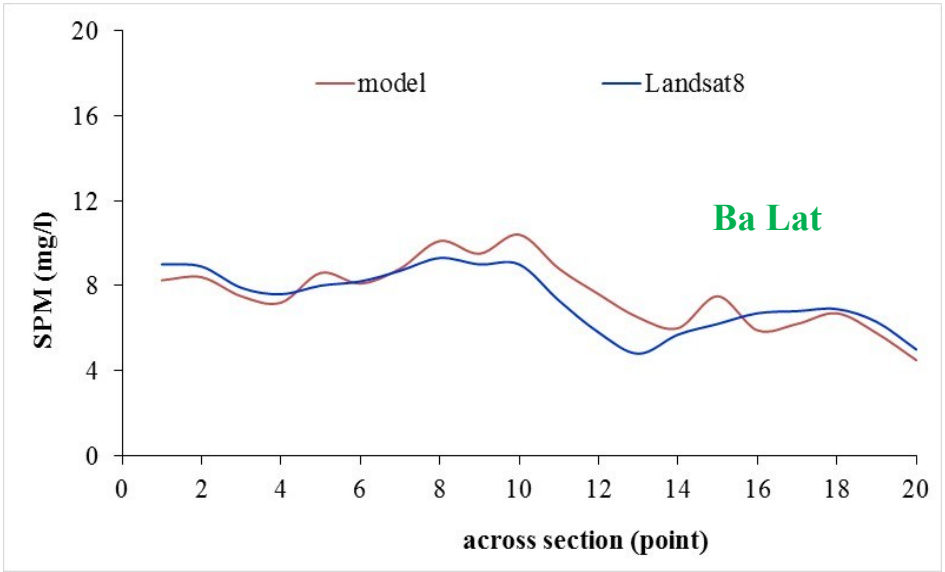


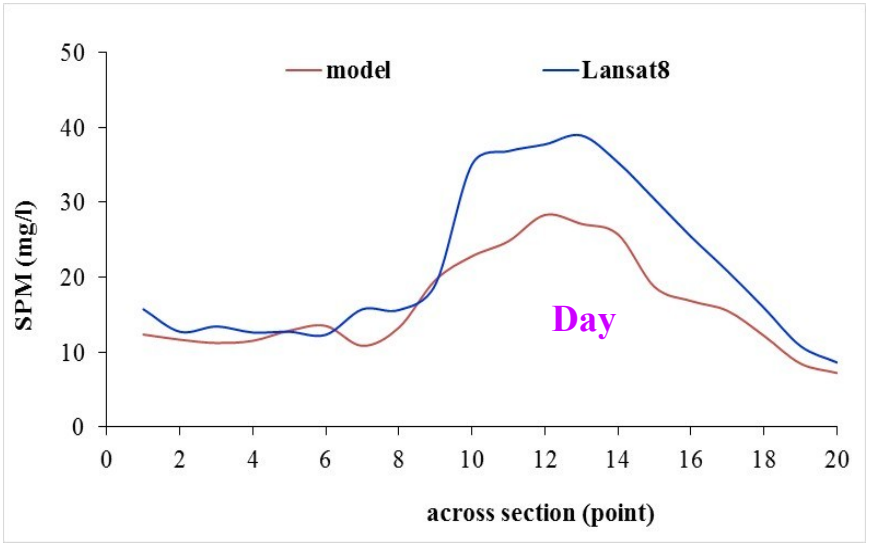
R= 0.9-0.94, E= 77-82%

Model validation with Landsat8 data: Sep. 25, 2014

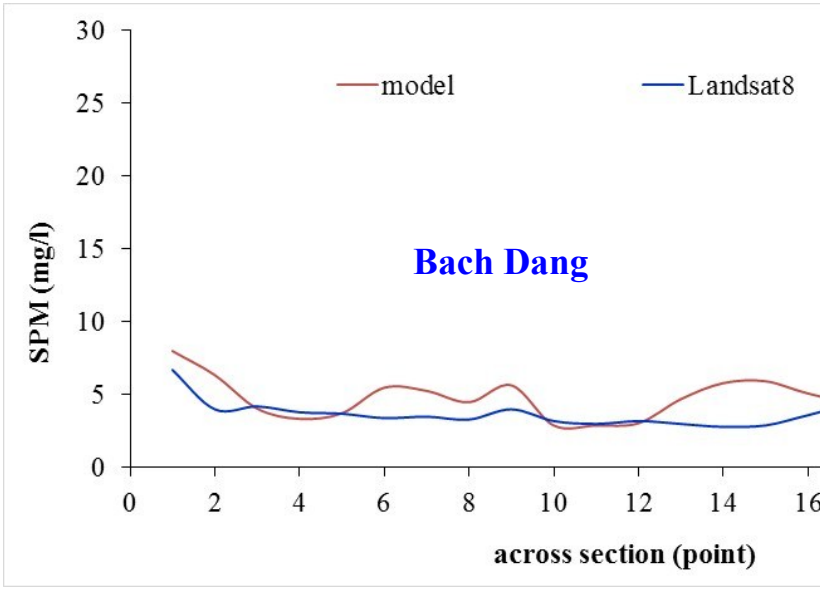


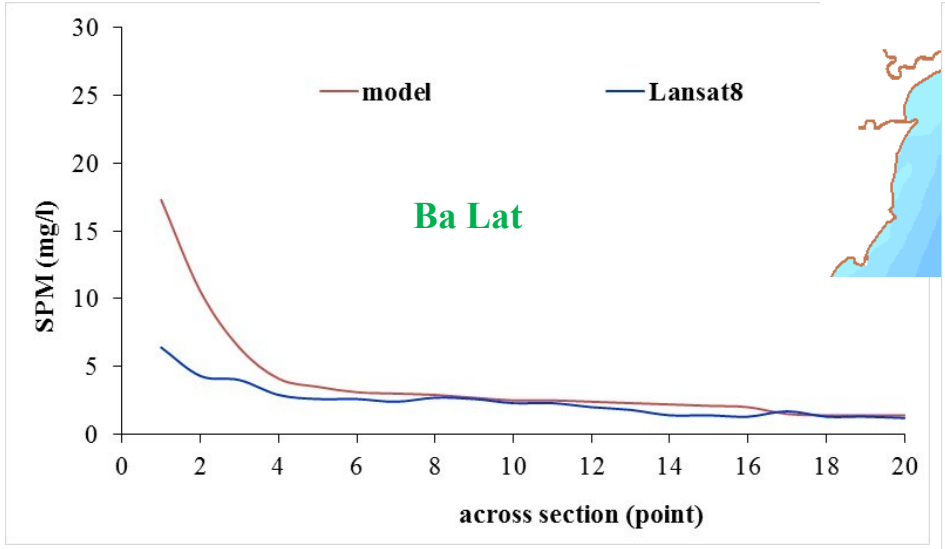


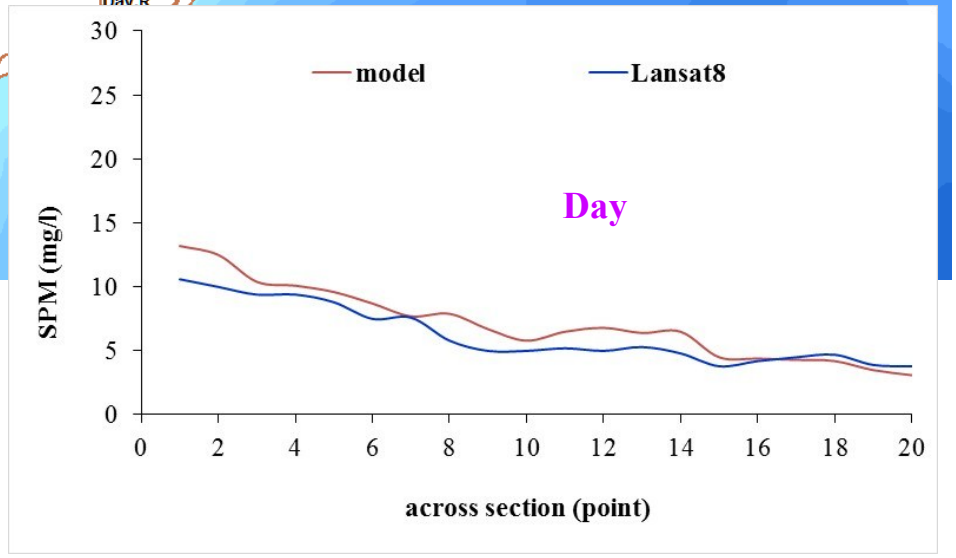


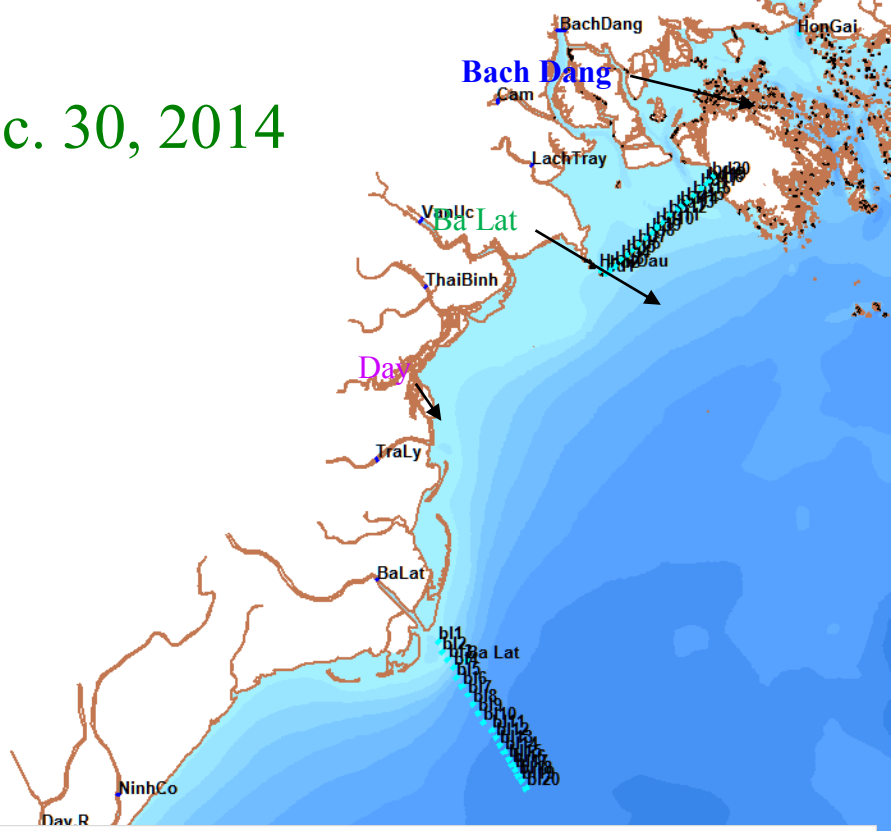


Model validation with Landsat8: Dec. 30, 2014



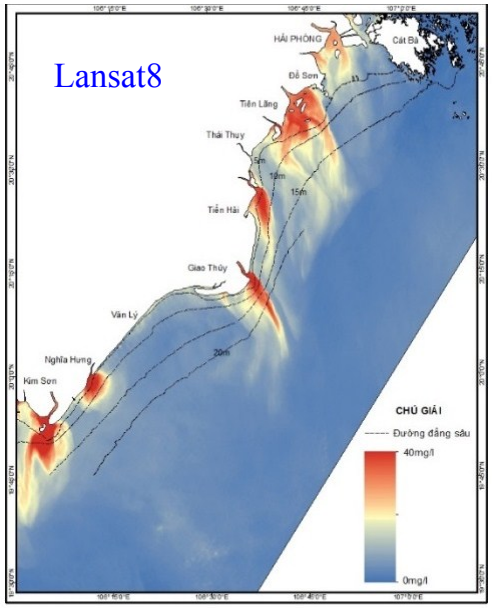


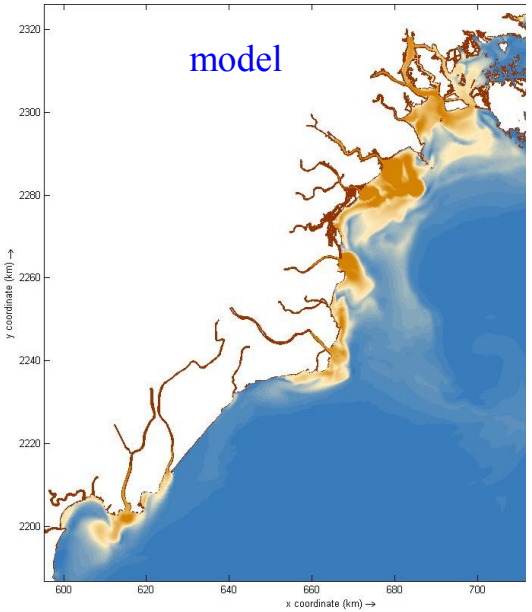


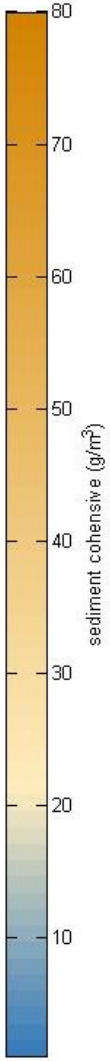


Model validation with **Landsat8**

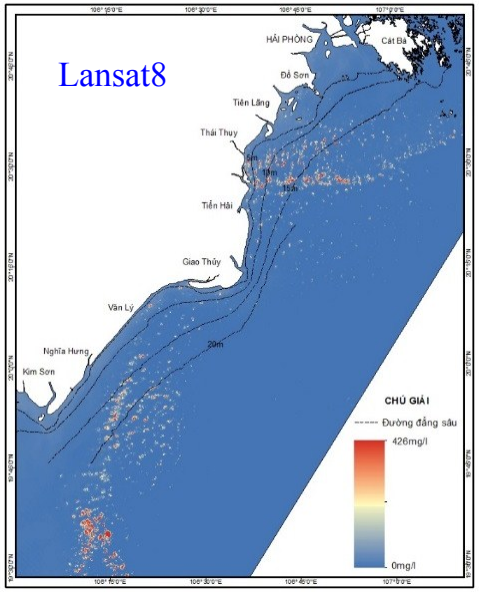
September 25, 2014

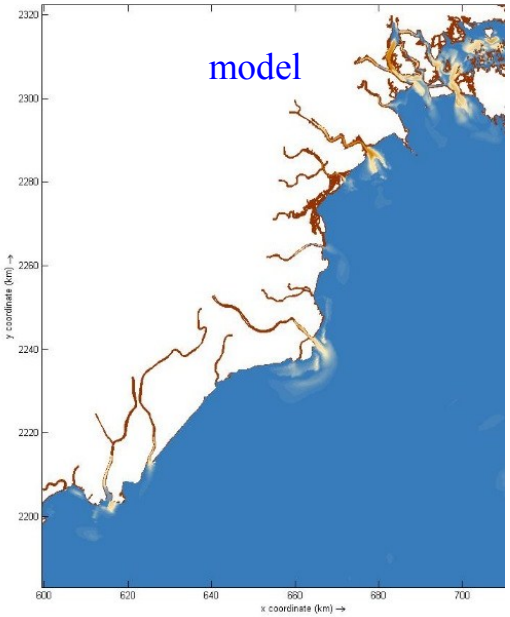






December 30, 2014

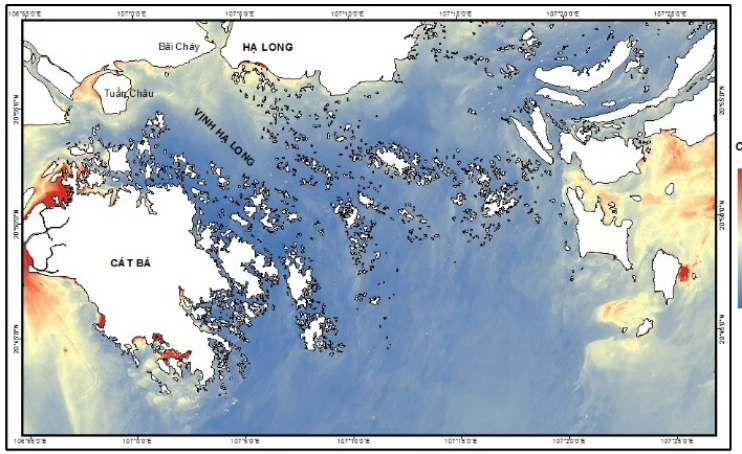




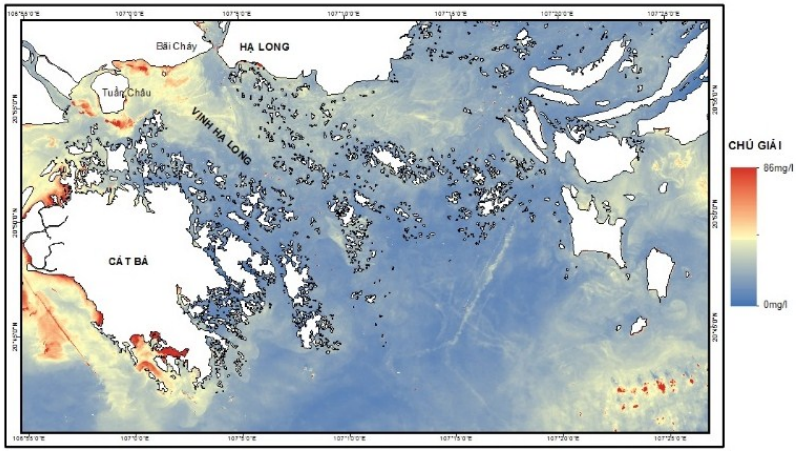
(Thao et al., 2015)

Model validation with **Landsat8**

September 25, 2014

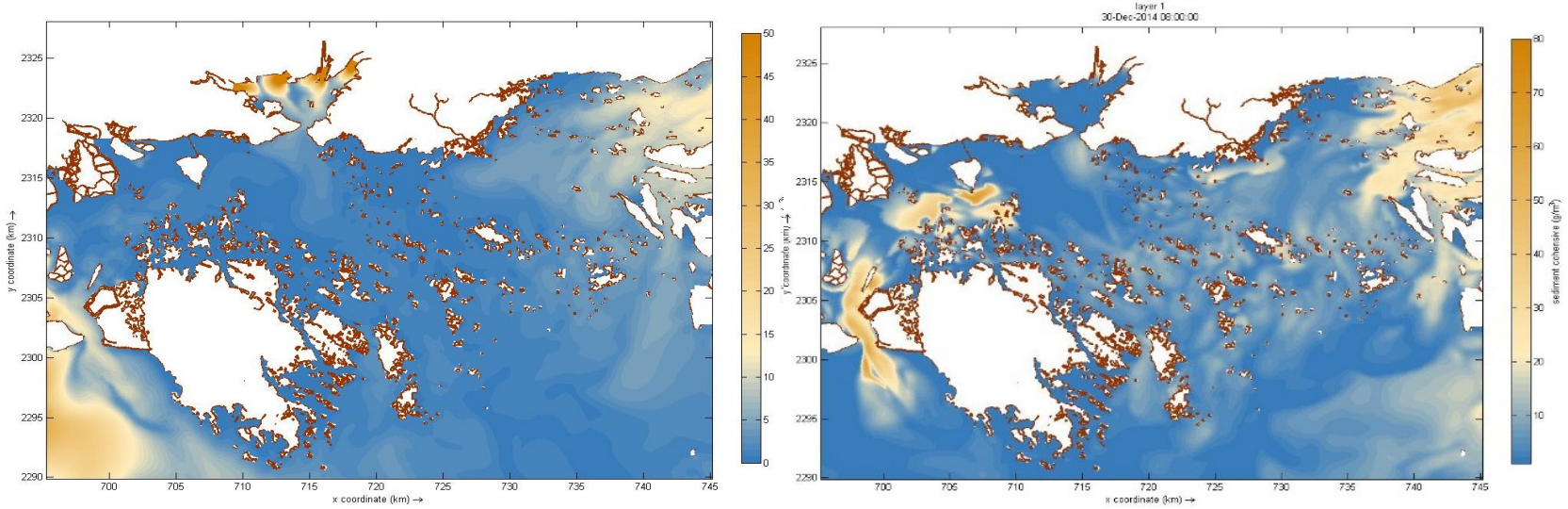


December 30, 2014



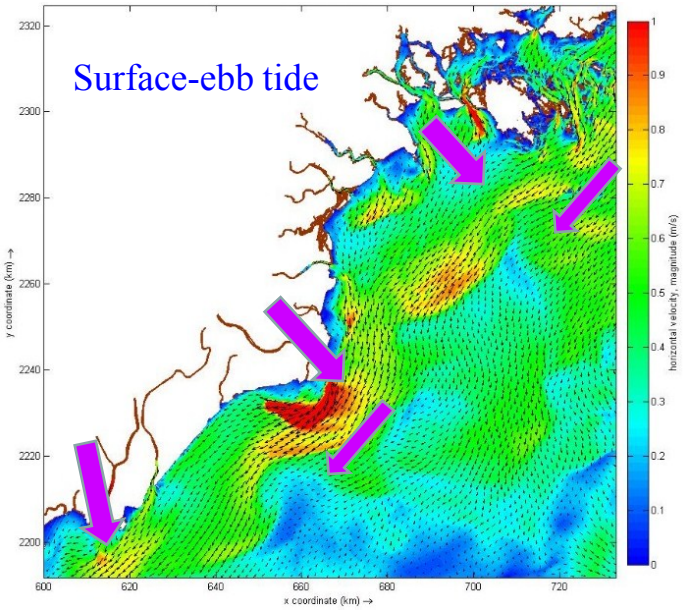
(Thao et al., 2015)

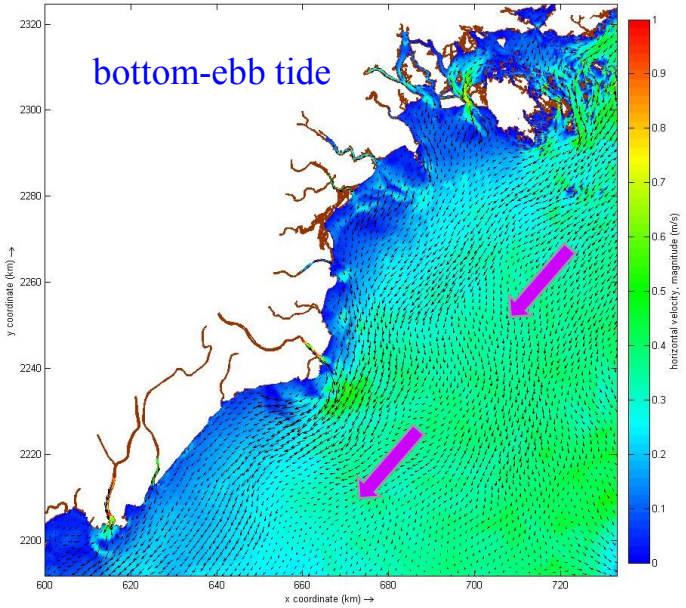
Lansat8

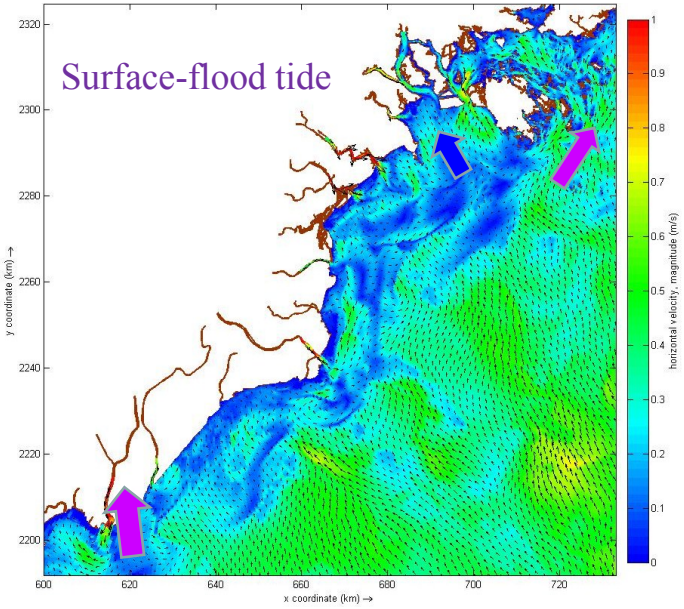


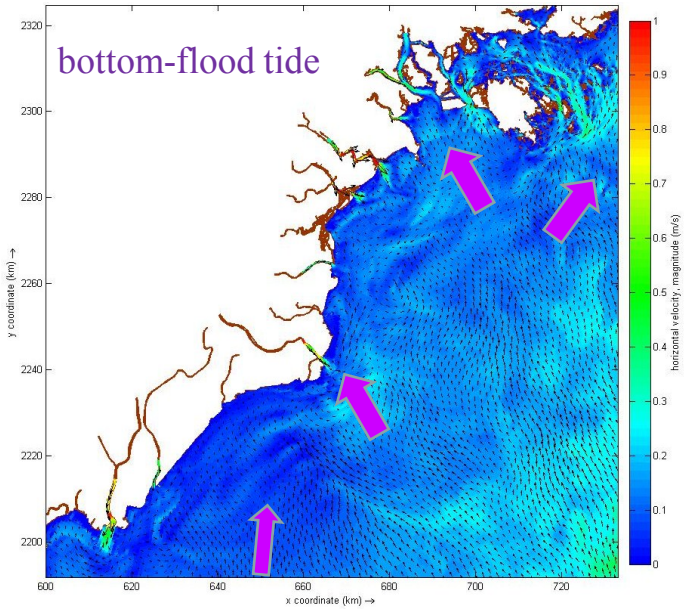
model

Results- spatial field current, July 2014

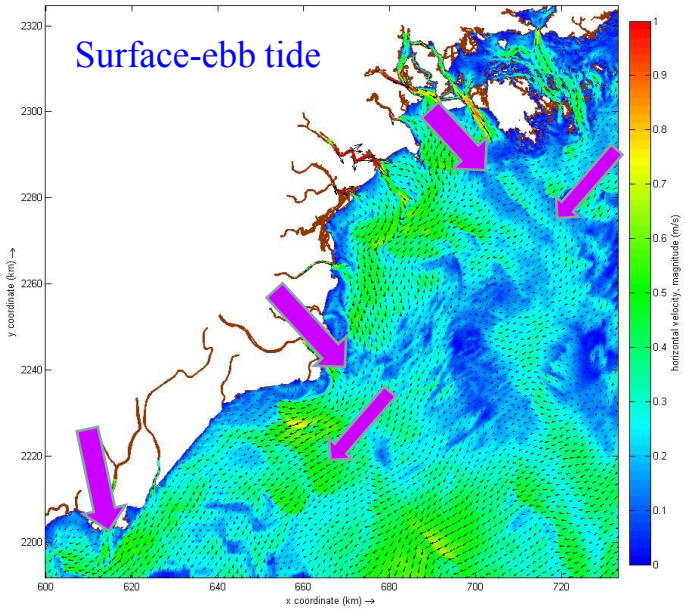


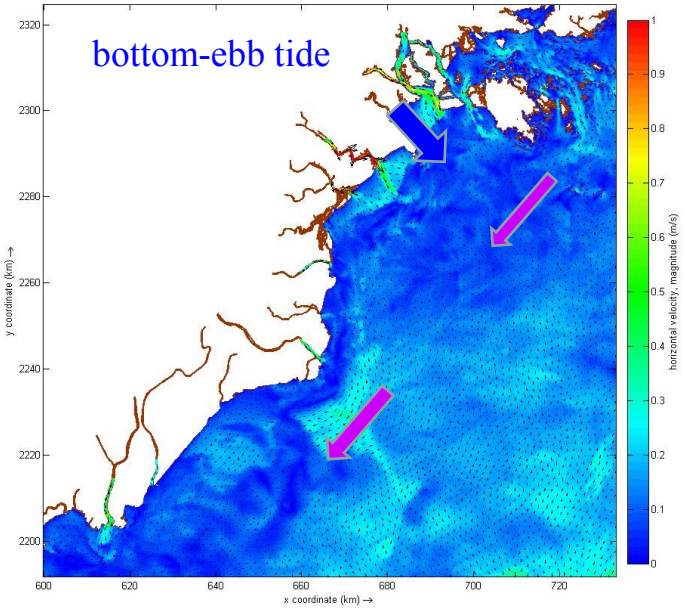


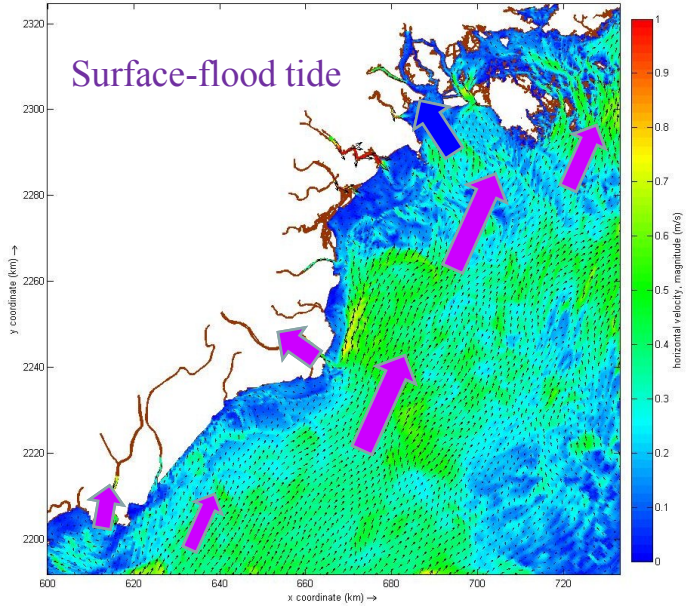


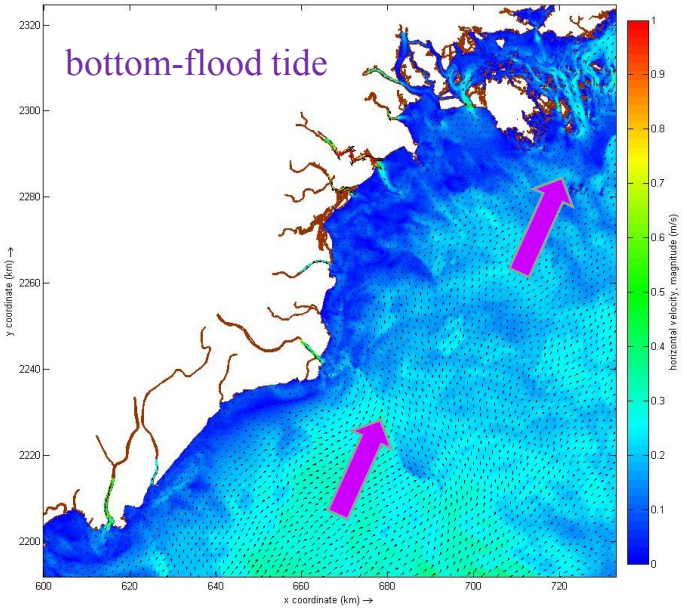


Results- spatial field current, September 2014

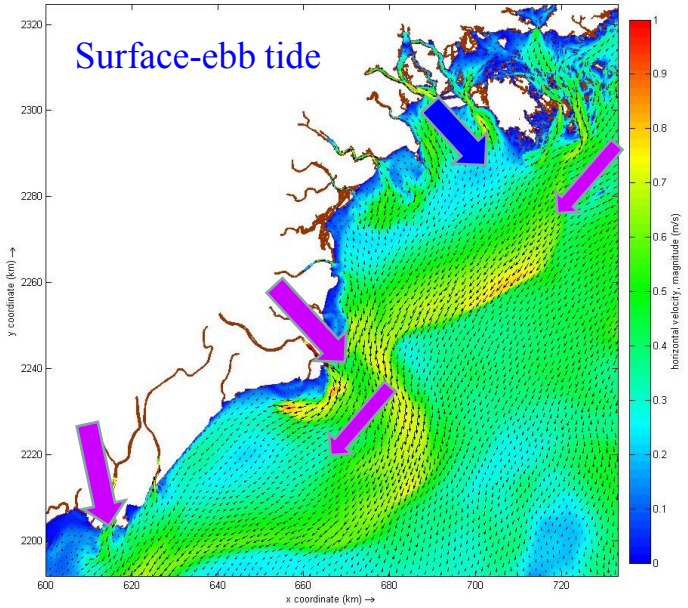


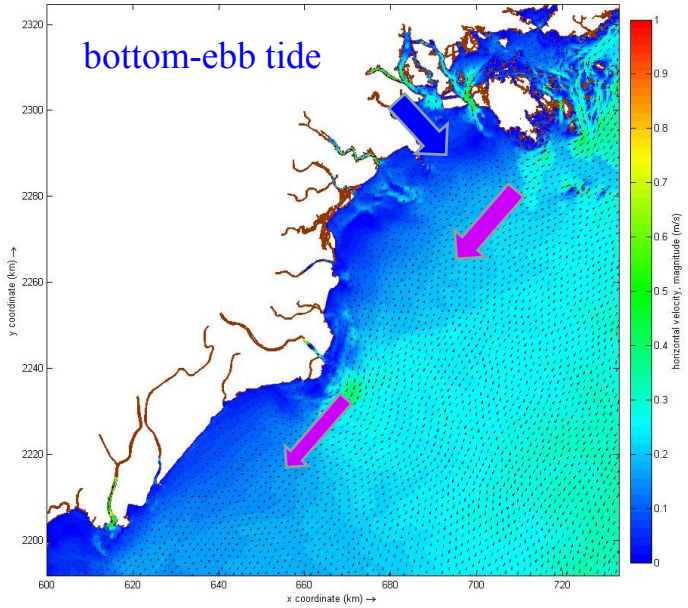


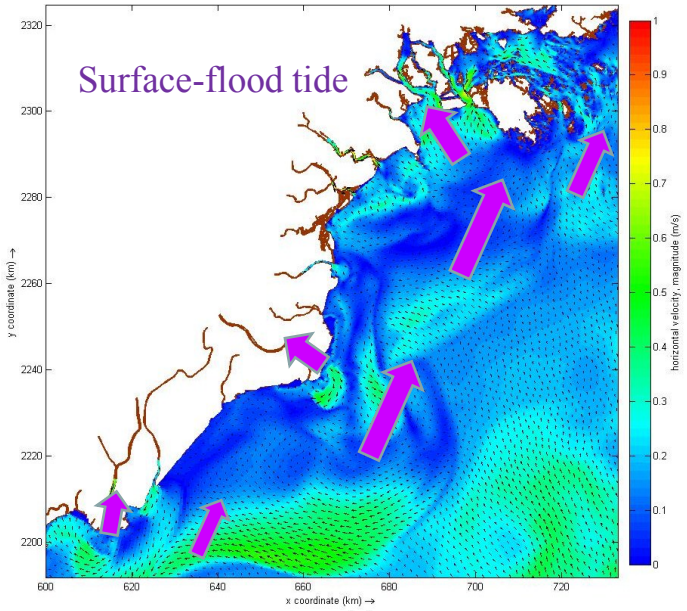


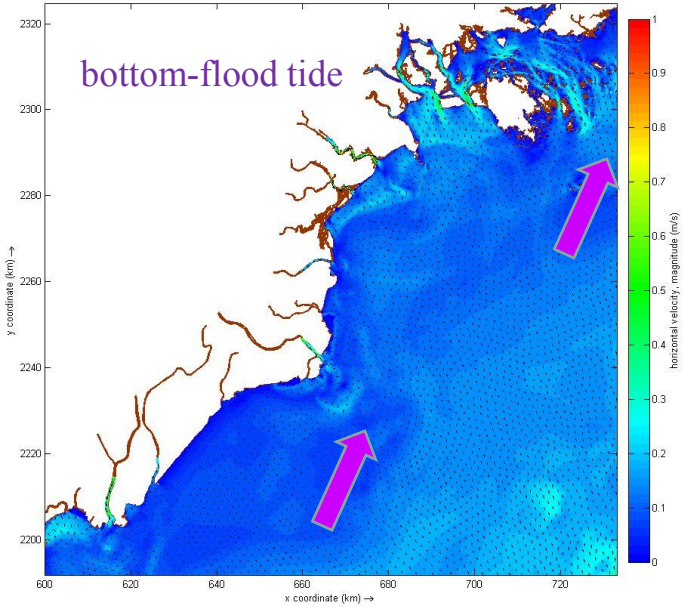


Results- spatial field current, December 2014

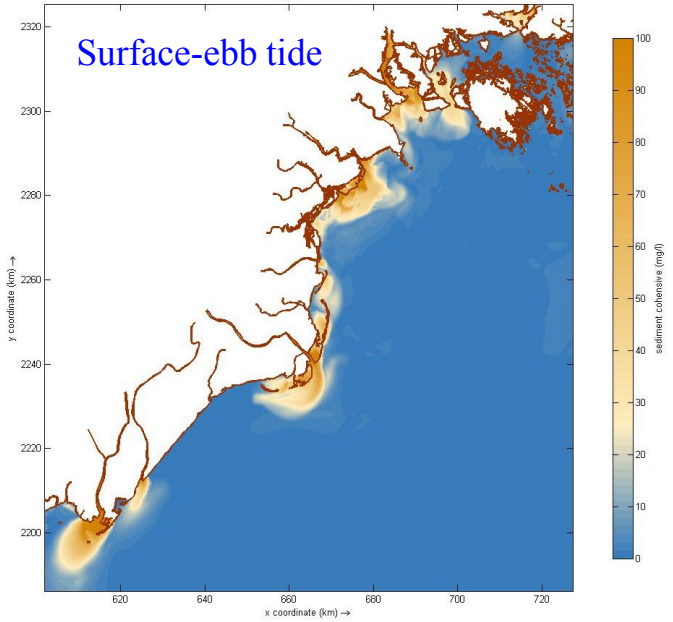


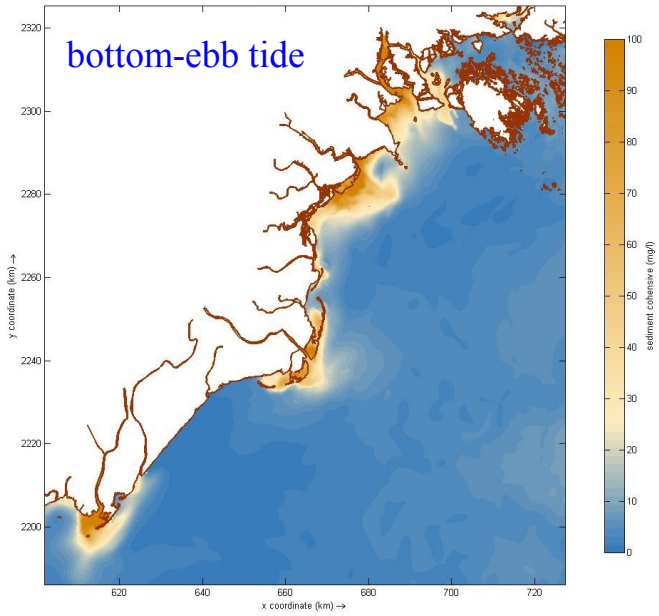


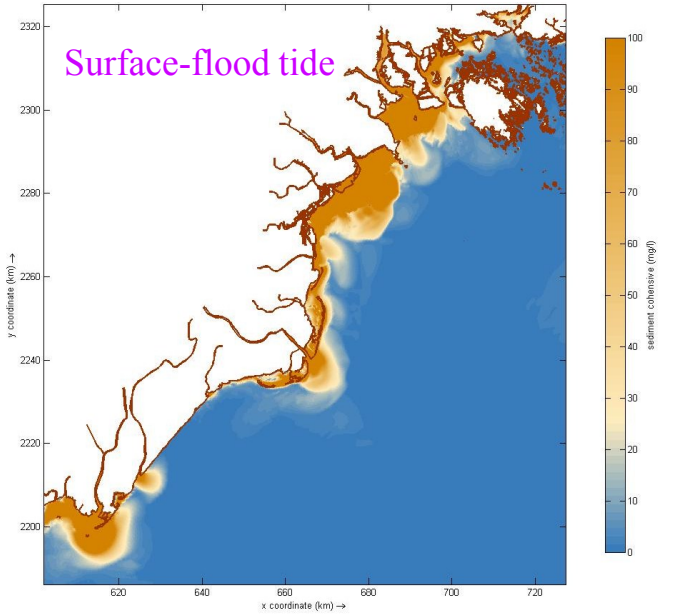


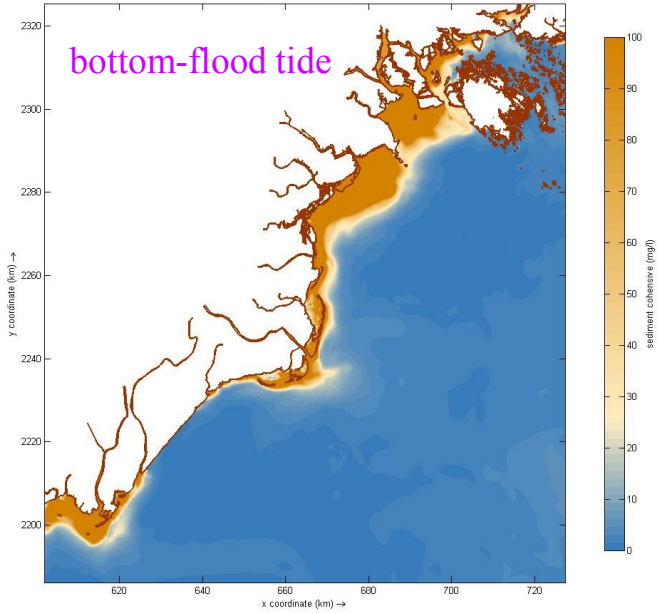


Spatial suspended sediment, July 2014

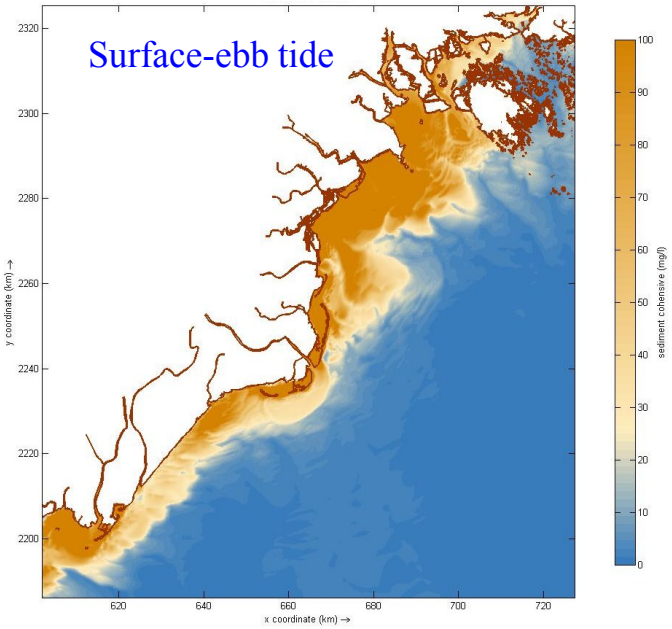


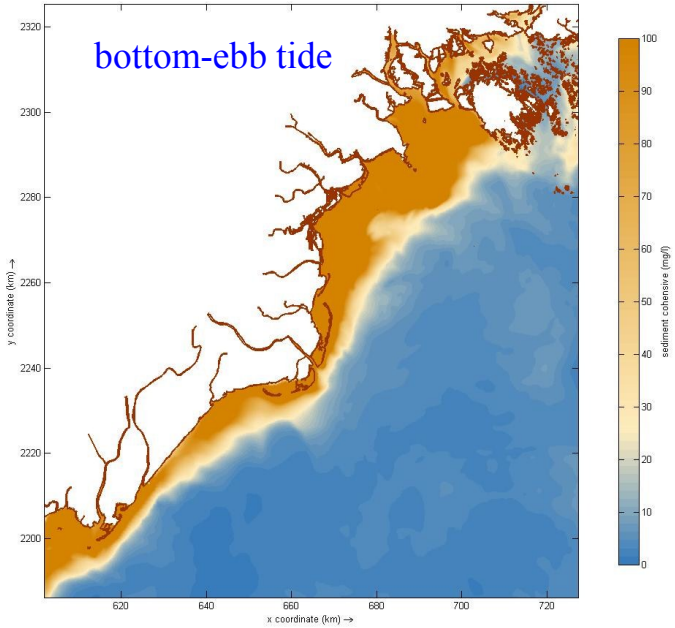


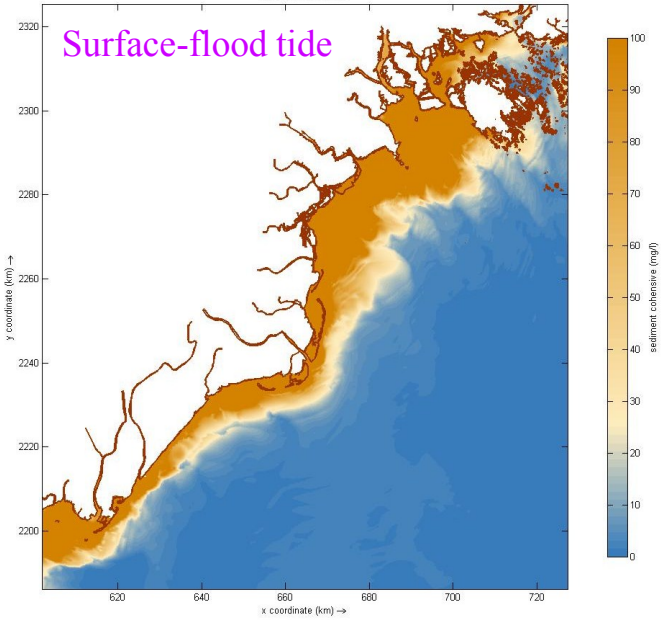


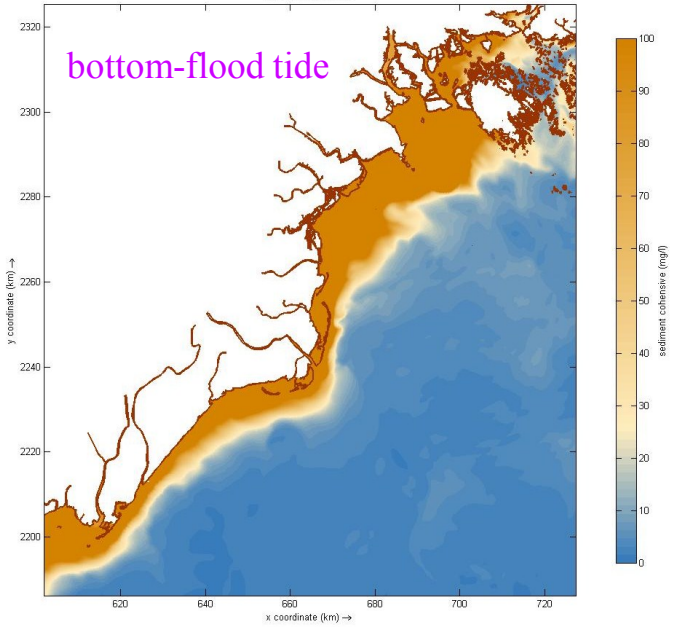


Spatial suspended sediment, September 2014

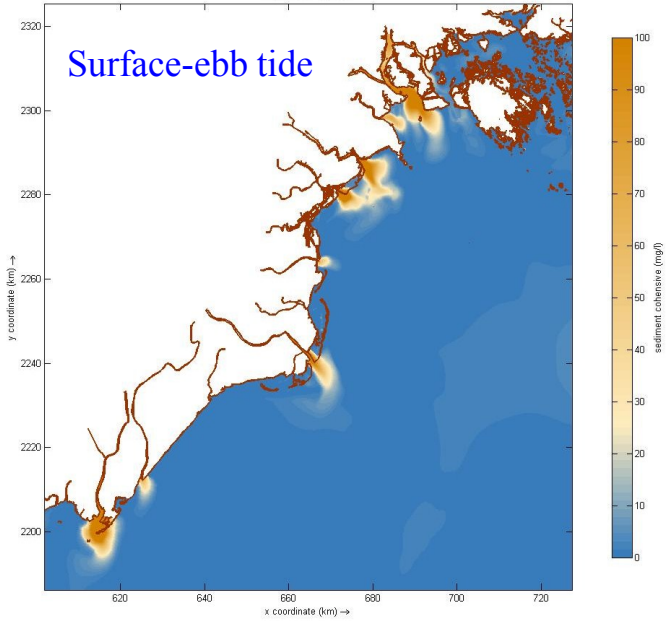


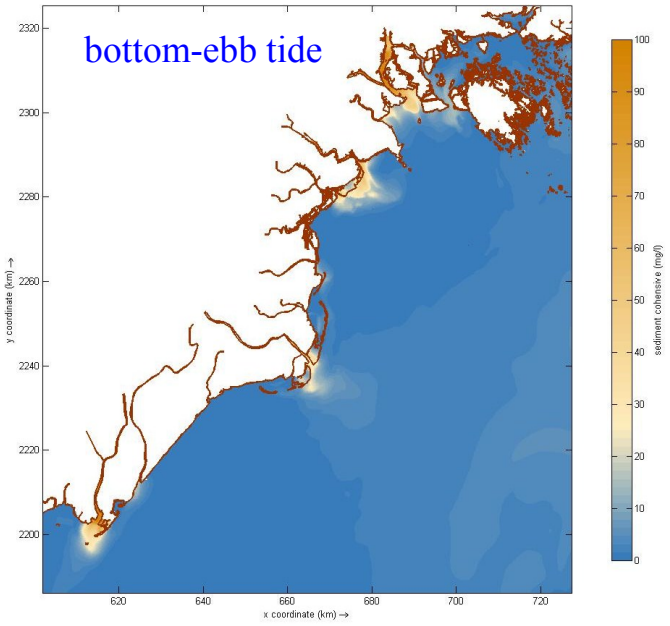


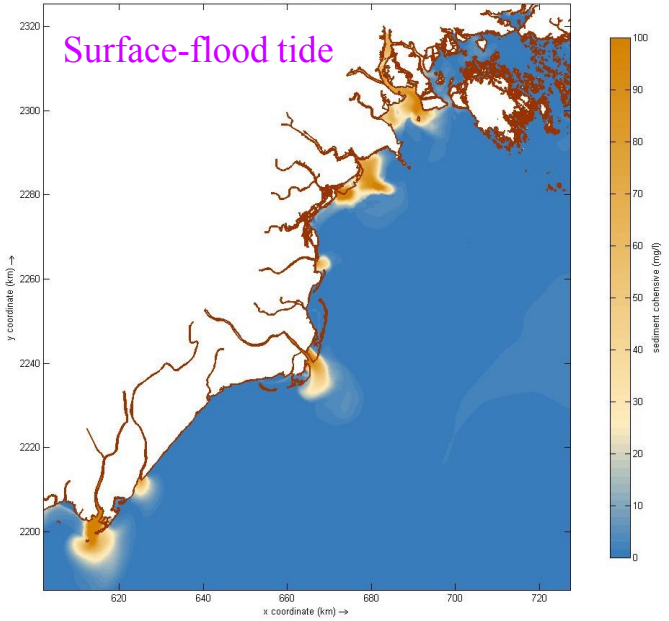


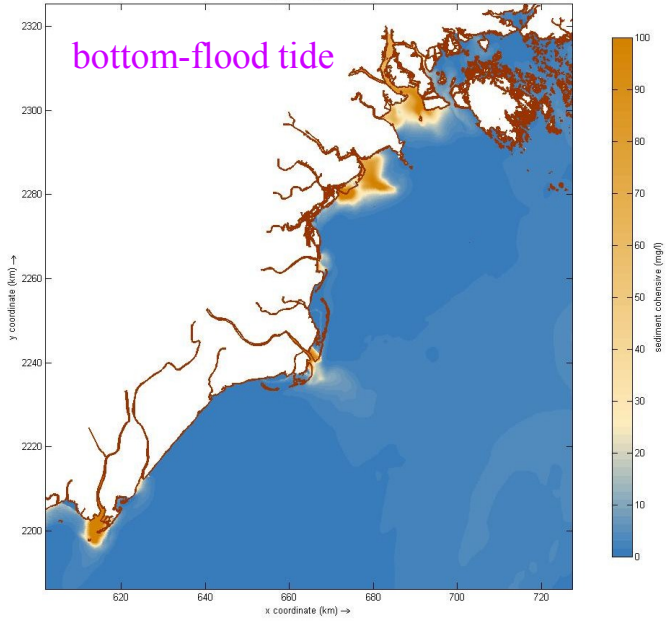


Spatial suspended sediment, December 2014

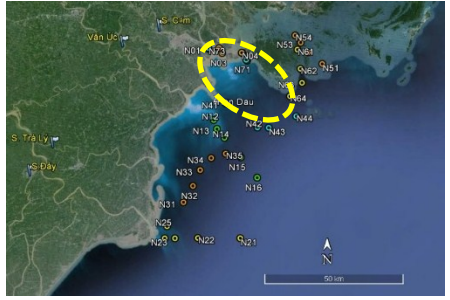




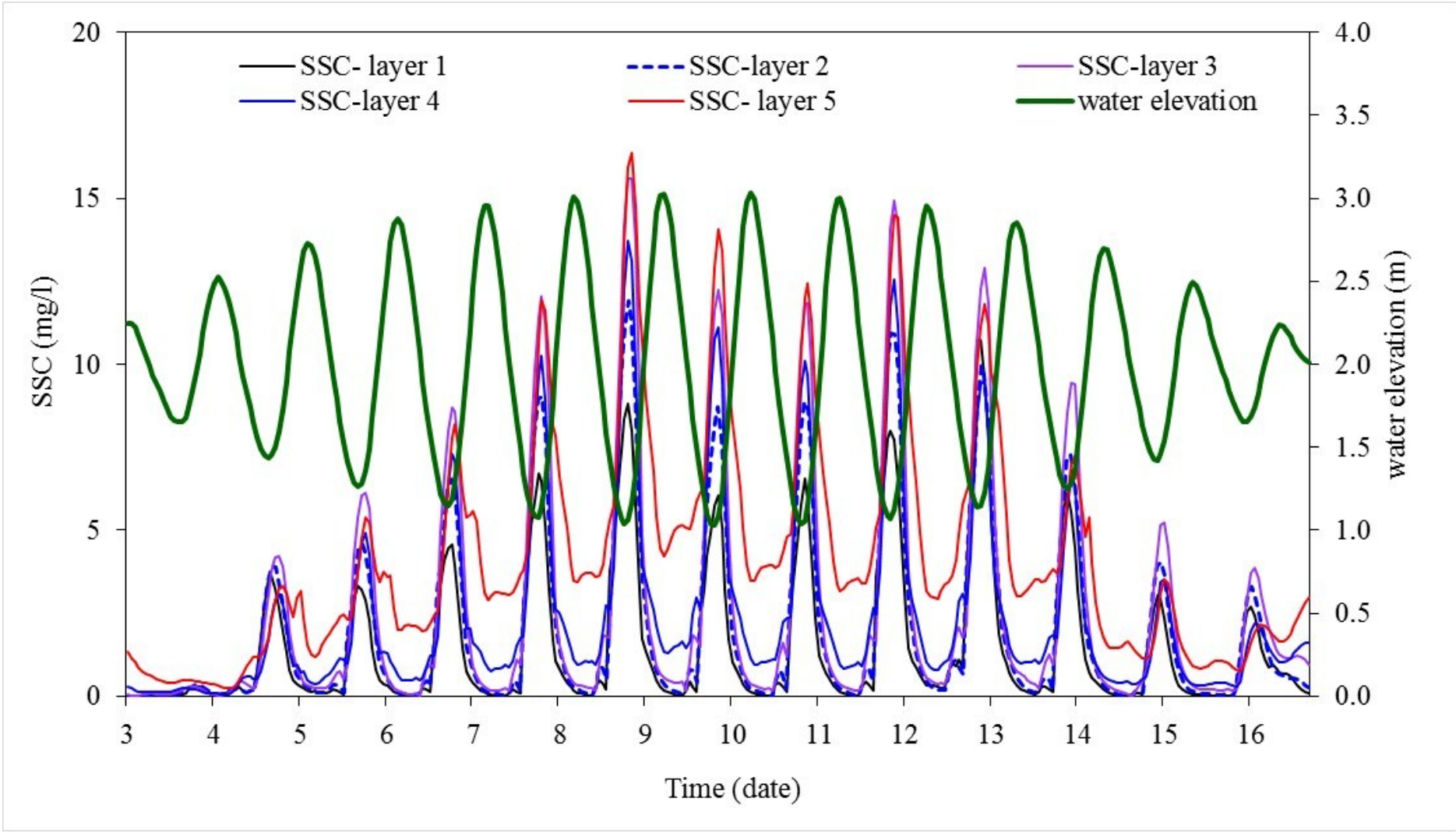




Results- temporal variation of SSC

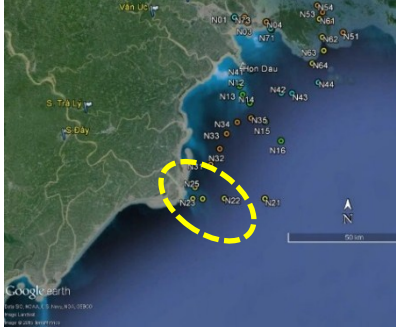


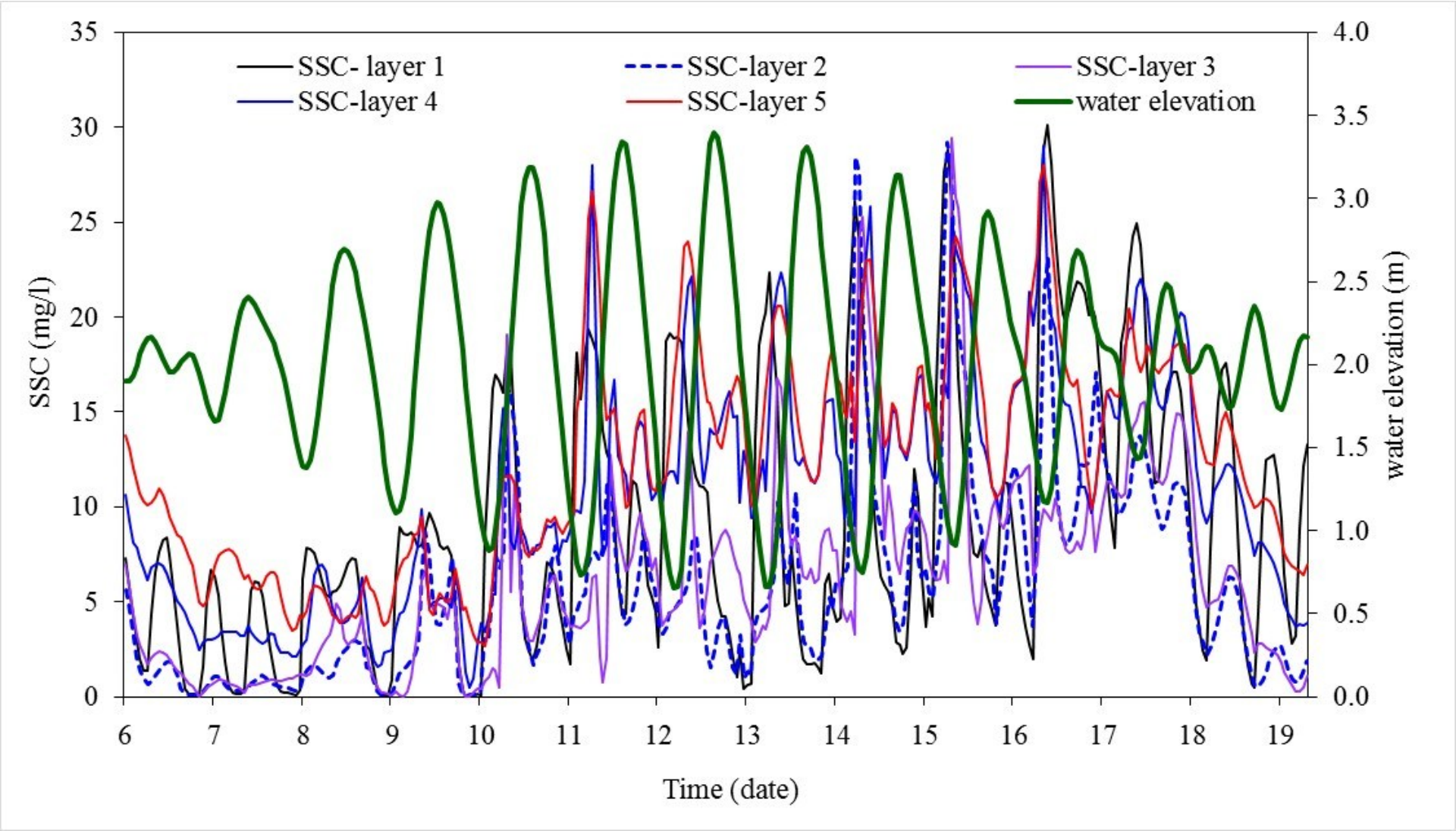
Bach Dang estuary coastal area, December 2014



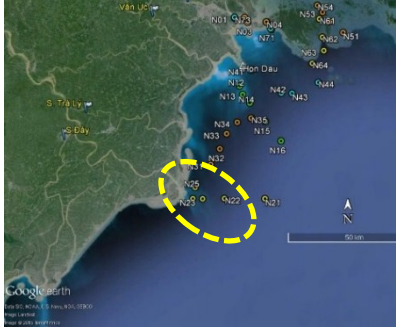
Results- temporal variation of SSC

Ba Lat mouth coastal area, July 2014



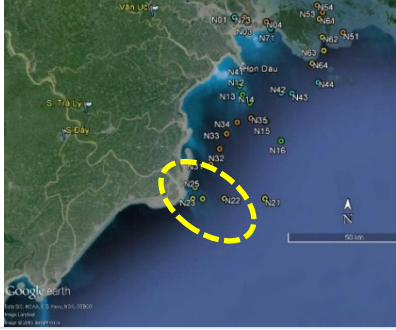


Results- temporal variation of SSC

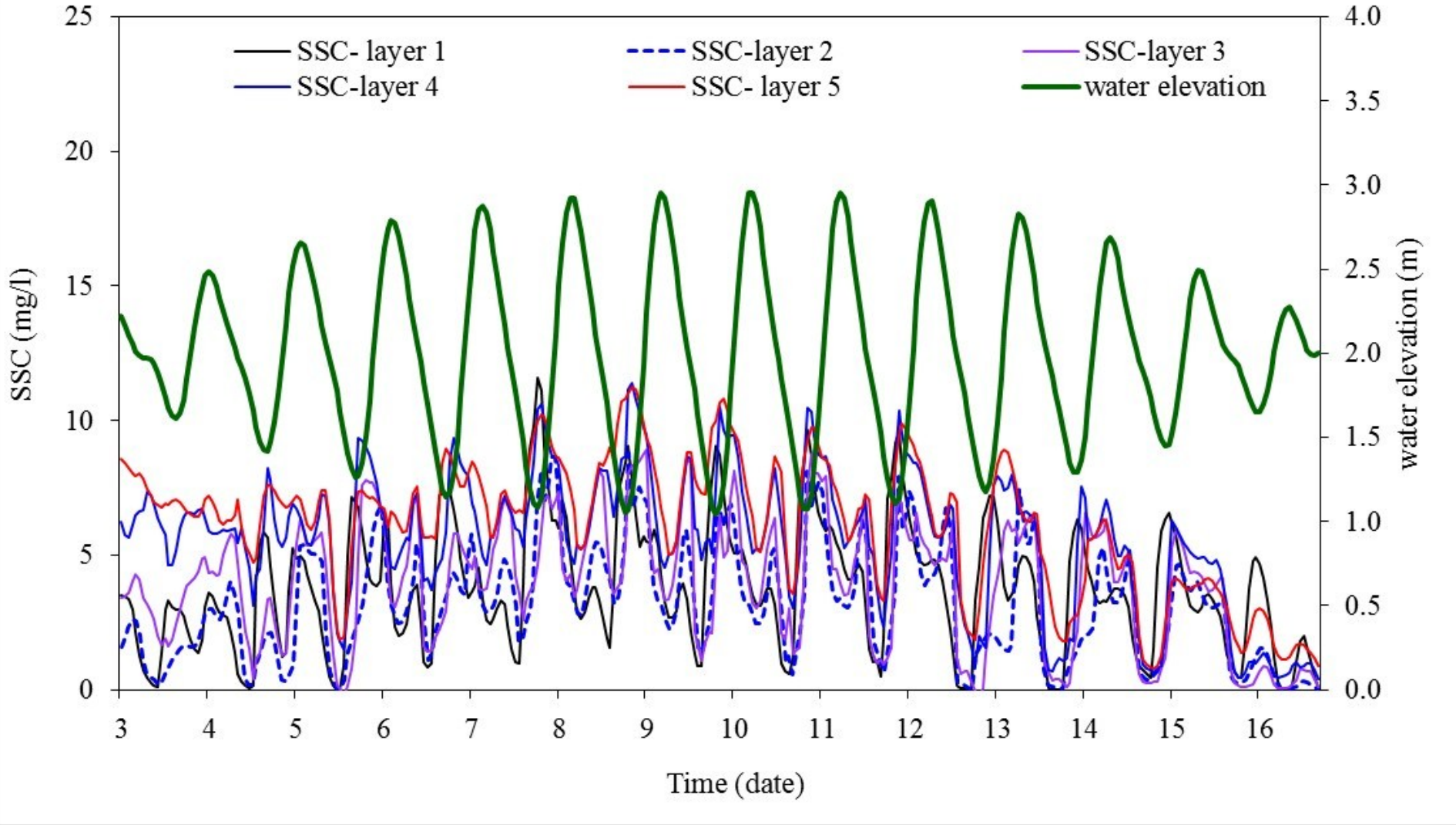


Ba Lat mouth coastal area, September 2014

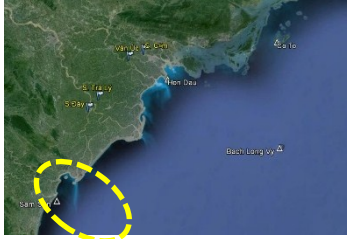
Results- temporal variation of SSC



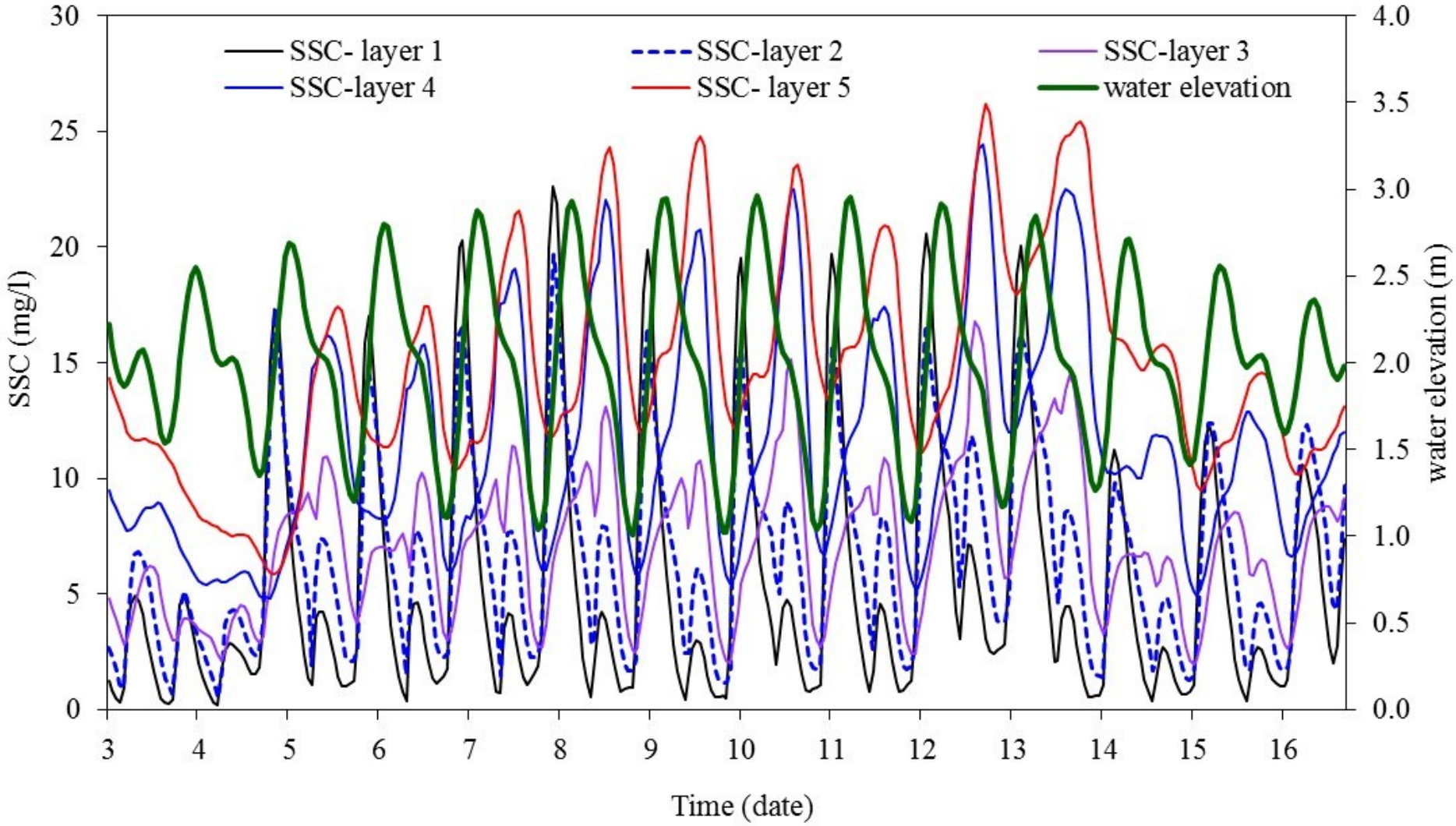
Ba Lat mouth coastal area, December 2014



Results- temporal variation of SSC

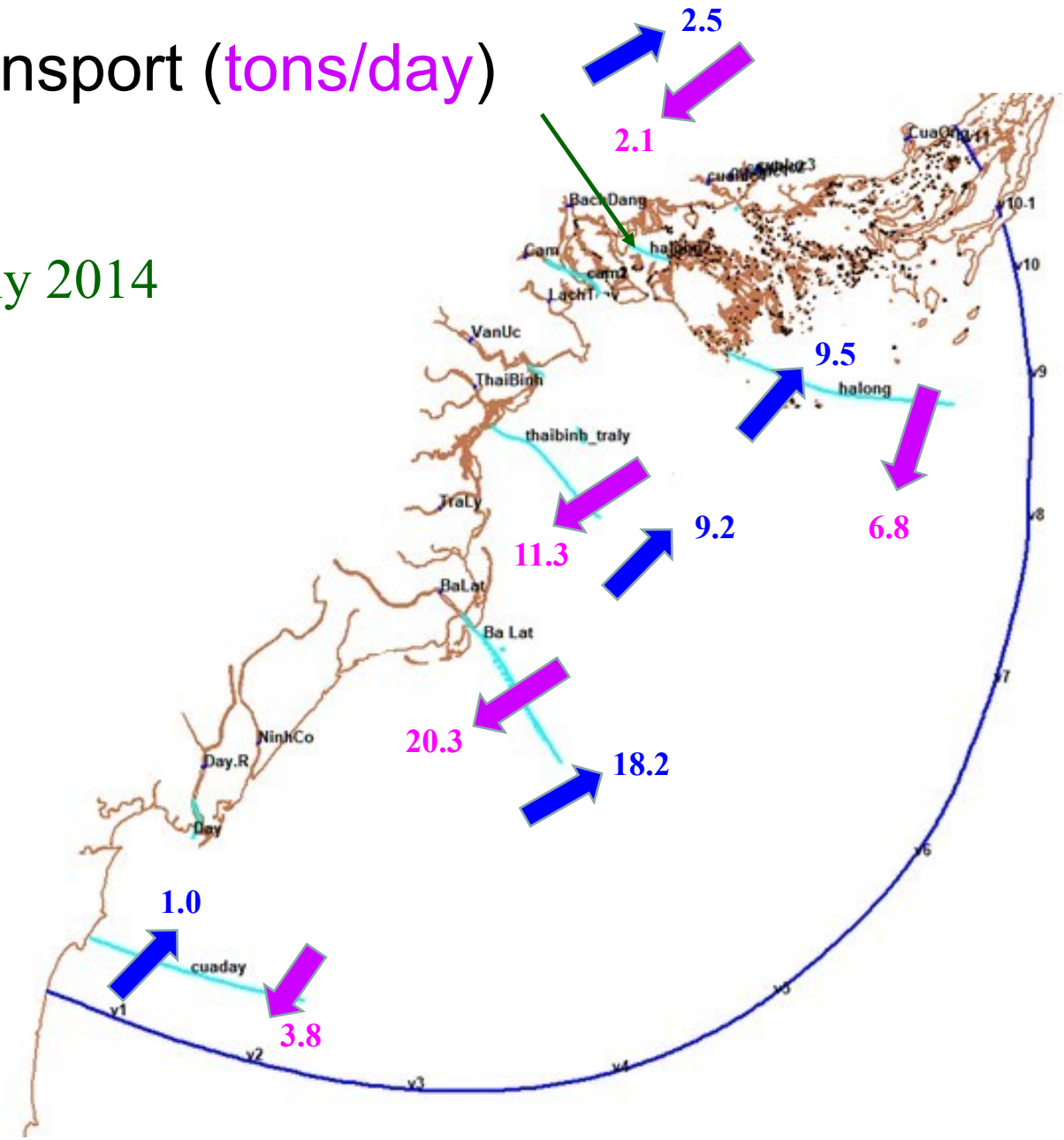


Day mouth coastal area, December 2014



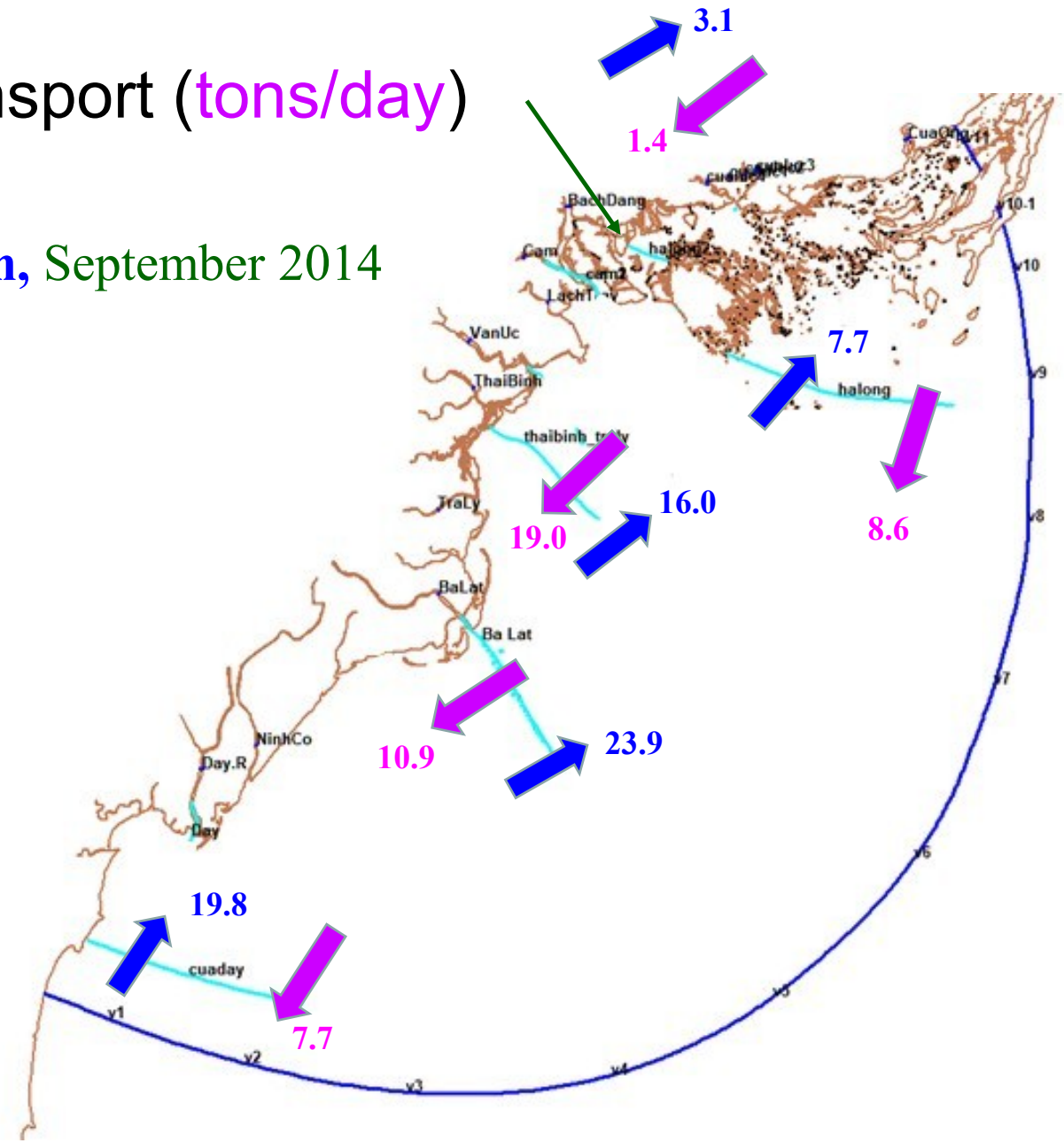
Alongshore transport (tons/day)

Rainy season, July 2014



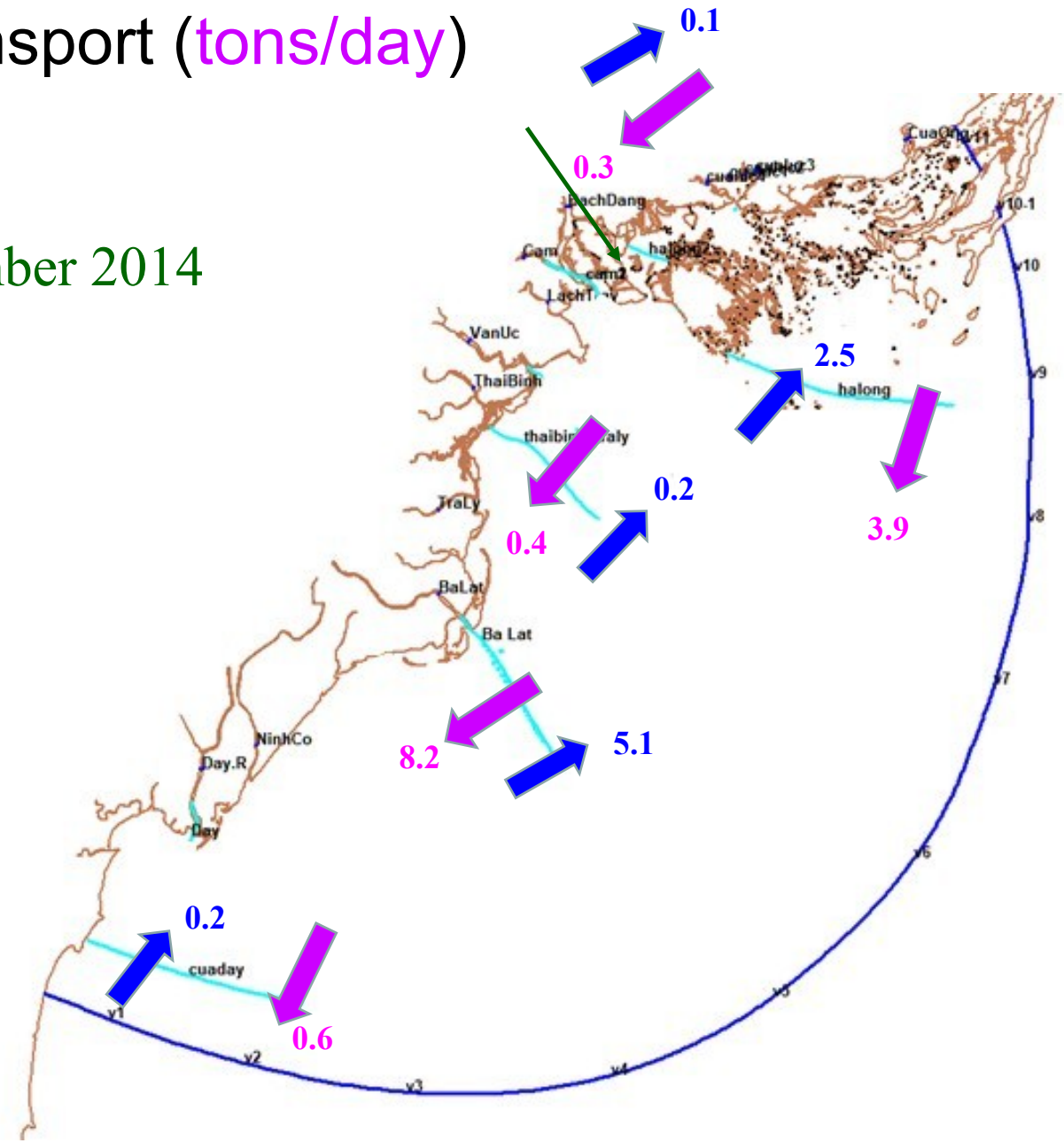
Alongshore transport (tons/day)

Later of rainy season, September 2014



Alongshore transport (tons/day)

Dry season, December 2014



Summary

- There are an acceptable agreement between model calculation and measurement data as well as satellite image
- Temporal distribution of suspended sediment and spatial variation of SSC strong depend on tidal oscillation, sediment flux from the river and wave actions.
- Alongshore sediment transport to southwest direction bigger than to northeast direction.

Ongoing works:

- Make more model calibration and validation
- sensitivity of suspended sediment dynamics to seasonal forcing: water river discharge, sediment flux, wave, wind.

Acknowledgment: This work acknowledges the support from the CEBioS programme of the Royal Belgian Institute of Natural Sciences (RBINS), Belgium.

Thanks for your attention!