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The State of the Art and Science of Coastal Engineering

Combined Effect of River Discharge and Storm Surge on Safe Water Level around Urbanized Estuary

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Contents

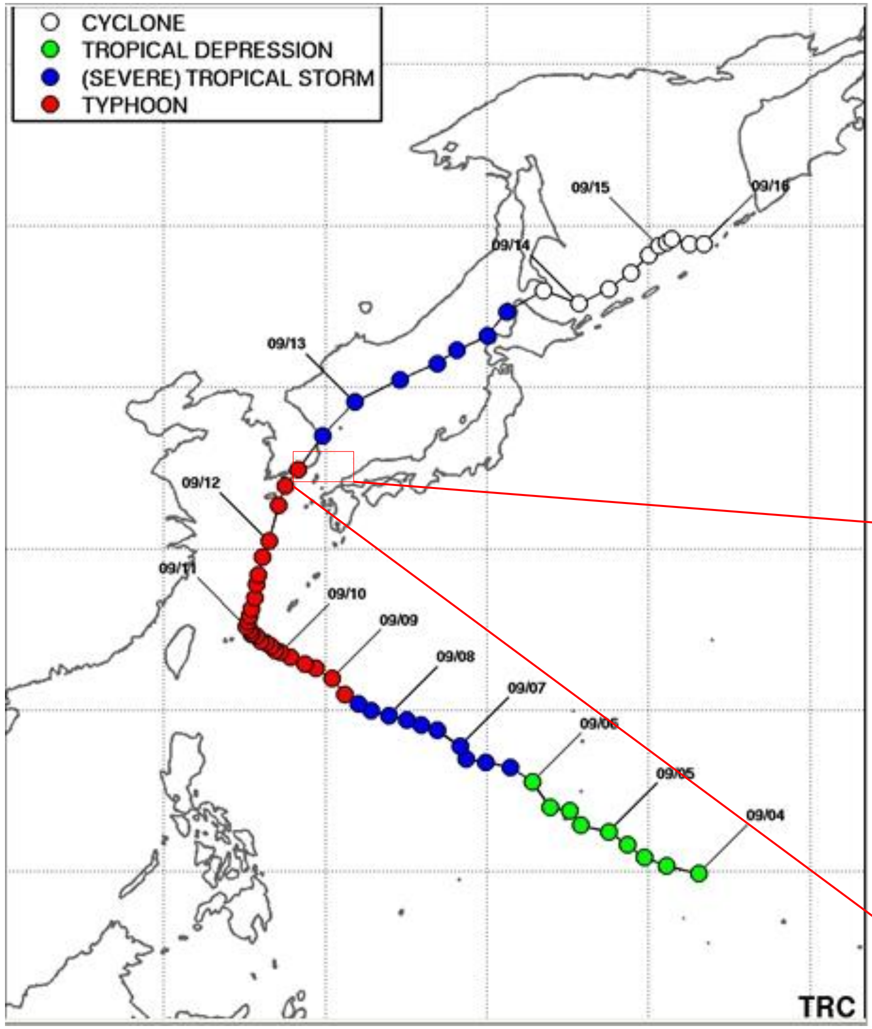
Introduction

Study area

- Suyeong bay is famous for residenc of many people around Suyeong River and most attractive site, such as Haeundae and Gwangalli beach, Marine city.
- There area was considerable damaged by Typhoon Maemi(2003), Muifa(2011),Chaba(2016)
- There are exposed to effects of global warming such as super typhoon, sea level rise and heavy rain. Especially, lowlands near river mouths because of the dual effect of flood from heavy rain and storm surge can be more severely damaged.

Fig.1. Study area

Target typhoon: Maemi 2003



- ❑ second deadliest named Typhoon of Korea : death 131 missing 12 property damage 3.5 billion dollars
- ❑ Category 4 storm
- ◆ Central pressure: 950 hPa
- ◆ Maximum Wind: 42.7 m/s
- ◆ Landfall: September 12th to 13th, 2003

Purpose of this study

- Accurate predictions in terms of the interaction between river discharge and storm surge is important and developed to water safety for people.
- In order to numerical simulation with storm surge and flood, this study was applied by the Advanced Circulation model (ADCIRC), which is conditions of Typhoon Maemi(0314).

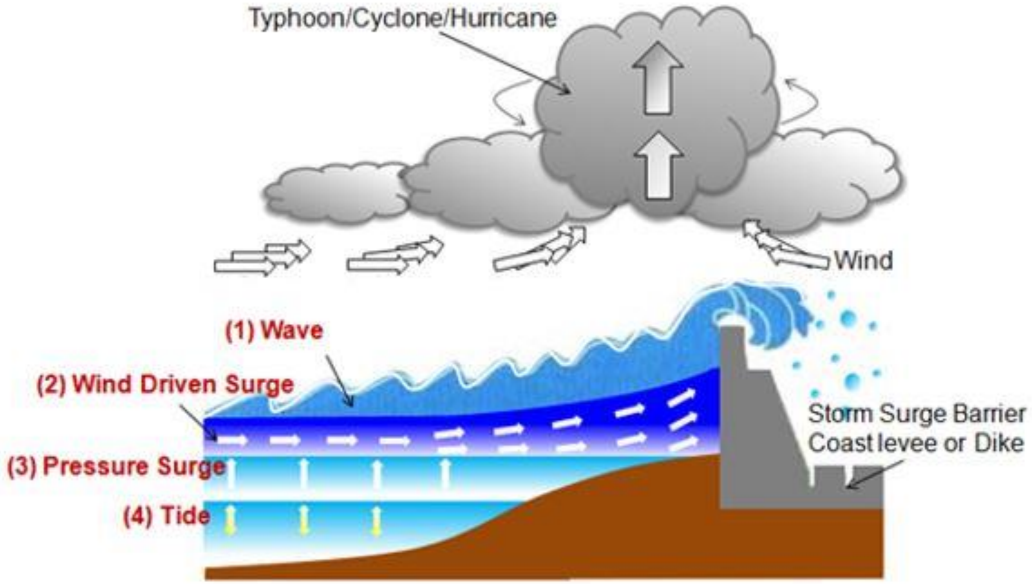


Fig. 2. Composition of Storm surge(Ohira et,2012)

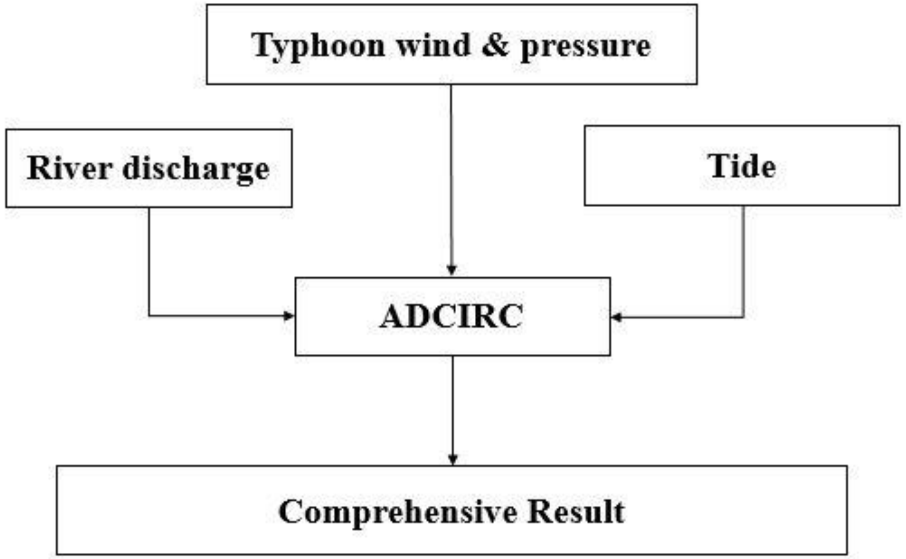


Fig. 3. Numerical Model Flow

Under storm condition
Water level = Wind driven surge + Pressure surge + Tide + River discharge

Methodology

Model domain

- These programs utilize the finite element method in space allowing the use of highly flexible, unstructured grids.
- The computational grid resolves the tidal, wind, atmospheric pressure, and river discharge forcing functions.

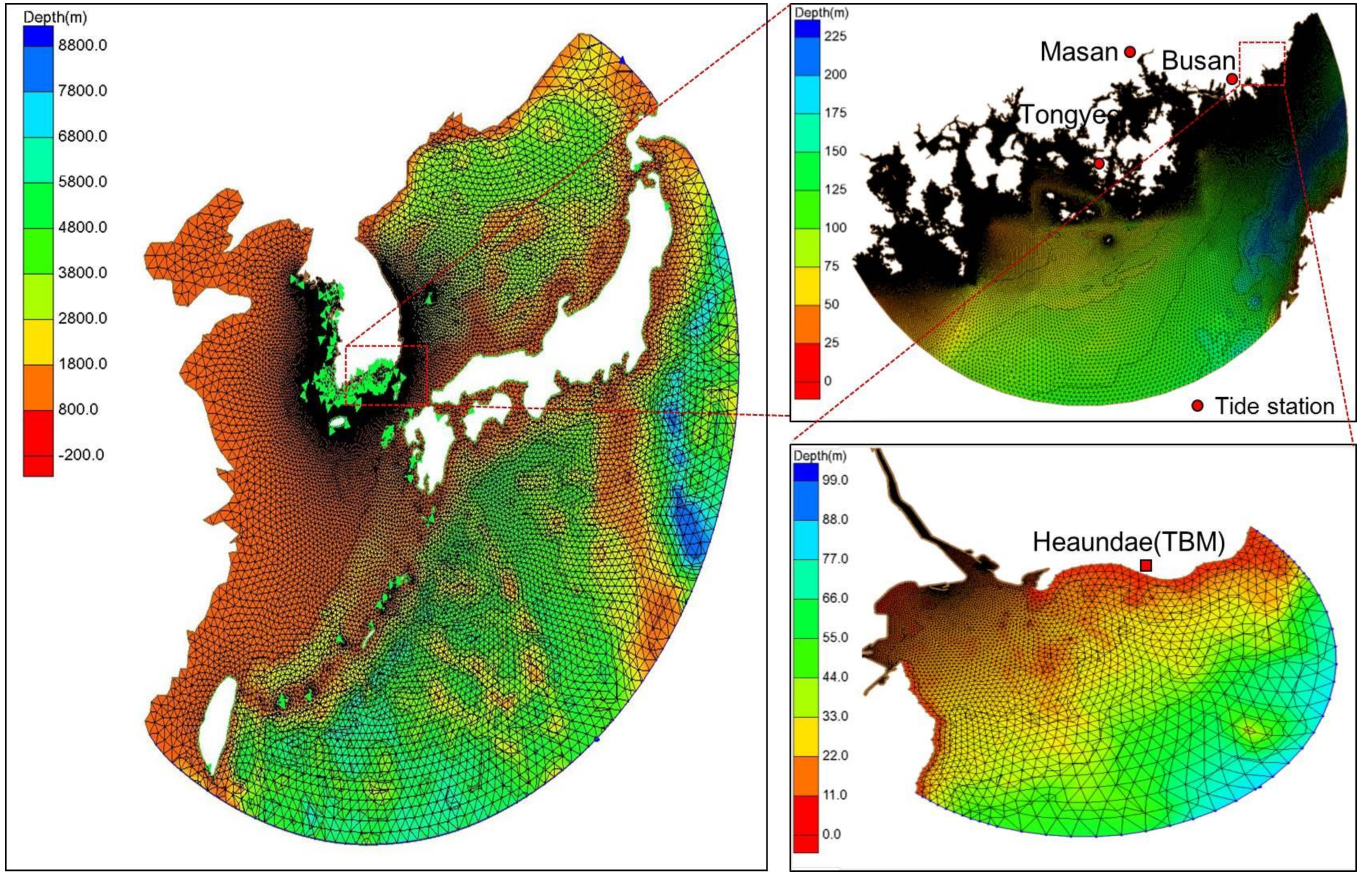


Fig. 4. Model domain and meshes

ADCIRC input data

- River discharge : A study on the Seasonal Variations of Fresh Water Distribution and Flushing Time in Suyeong bay(Lee, 1991) based on the monthly observation from May 1989 through April 1990.

수영만에 유입된 담수의 체류시간과 그 계절적 변동 특성

이병걸 · 조규대 · 김동선*
부산수산대학교, *여수수산대학
(1991년 8월 10일 접수)

A Study on the Seasonal Variations of Fresh Water Distribution and Flushing Time in Suyoung Bay

Byung-Gul Lee, Kyu-Dae Cho and Dong-Sun Kim*
National Fisheries Univerisy of Pusan, *Yosu National Fisheries College
(Recieved August 10, 1991)

River flow rates for the various simulation

	Total Fresh Water (ton)	River Discharge (ton/sec)	Flushing Time (day)
May	3,660,033	4	10.6
August	130,826,880	1,130	1.34
November	4,792,366	4	13.87
February	3,168,266	4	9.23

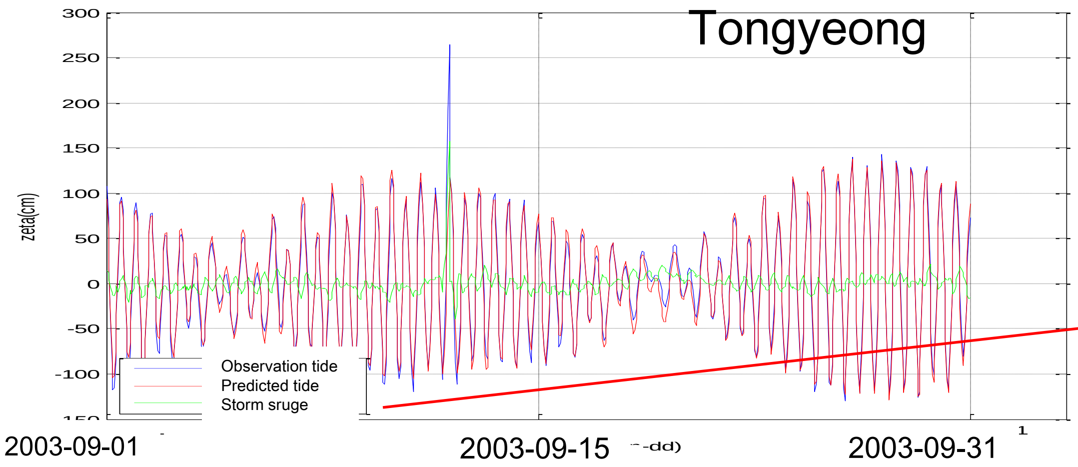
ADCIRC input data

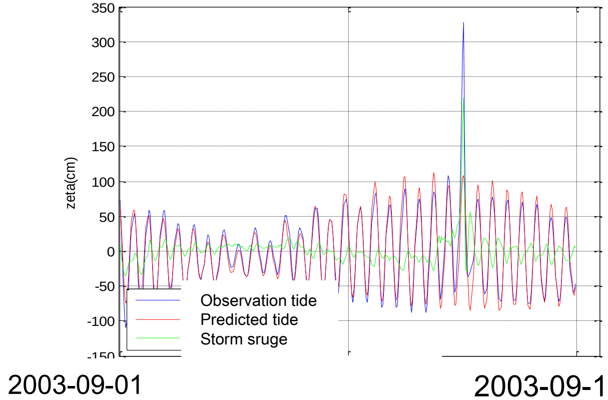
- Tidal condition: 4 tidal constituents(M2,S2,O1,K1) using data from Korea Hydrographic and Oceanographic Administration(KHOA).
- Storm Surge : The wind field model is parameterized according to the forward velocity and pressure field of Typhoon Maemi. Typhoon Maemi wind data using the Radius of maximum wind speed(rmax), center of pressure(pc), Maxmium wind speed(Vmax) from Korea Meteorological Administration(KMA).

Water level conditions in Advance Circulation Model for Oceanic,Coastal, and Estuarine Water (ADCIRC) simulation

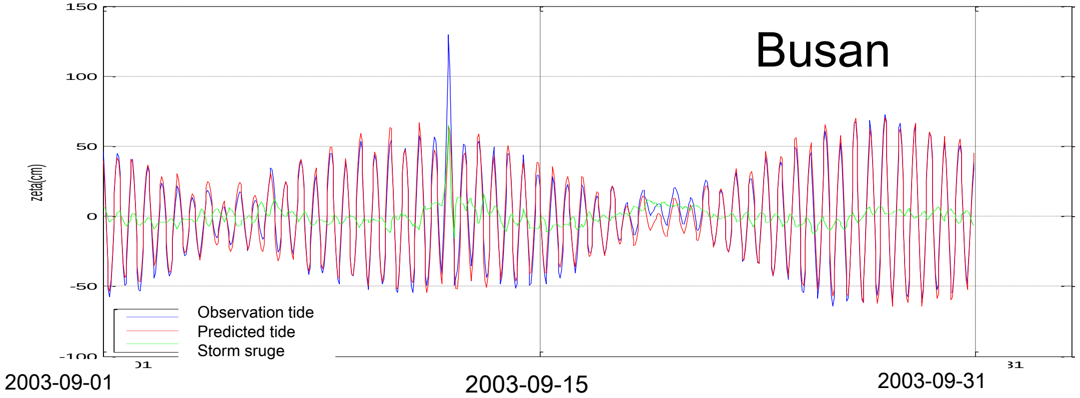
Input	case1	case 2	case 3	case 4
River discharge (1130m³/s)		○		○
Tide (M_2,S_2,O_1,K_1)	○	○	○	○
Storm surge (Typhoon Meami)			○	○

Observation data(tidal station)

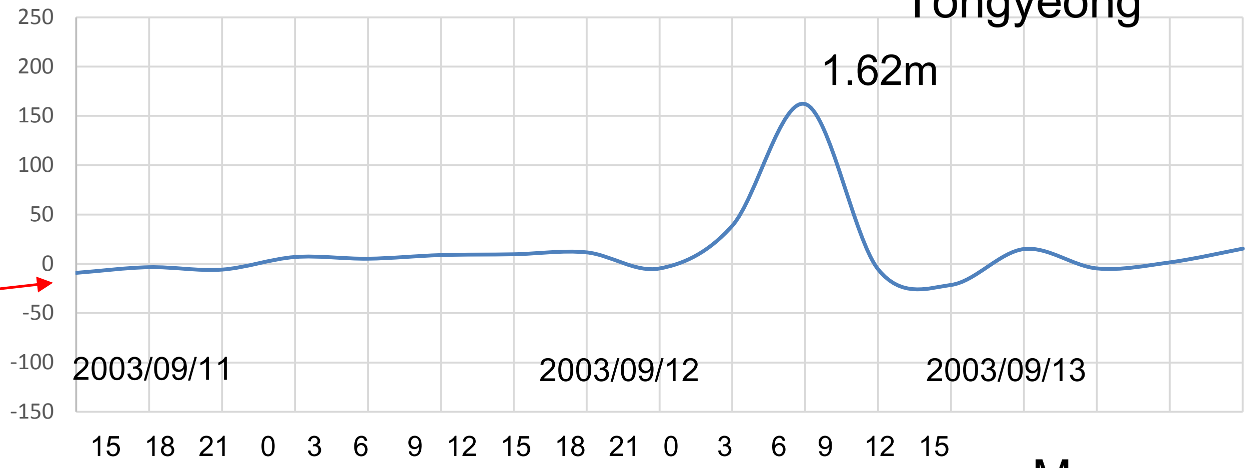


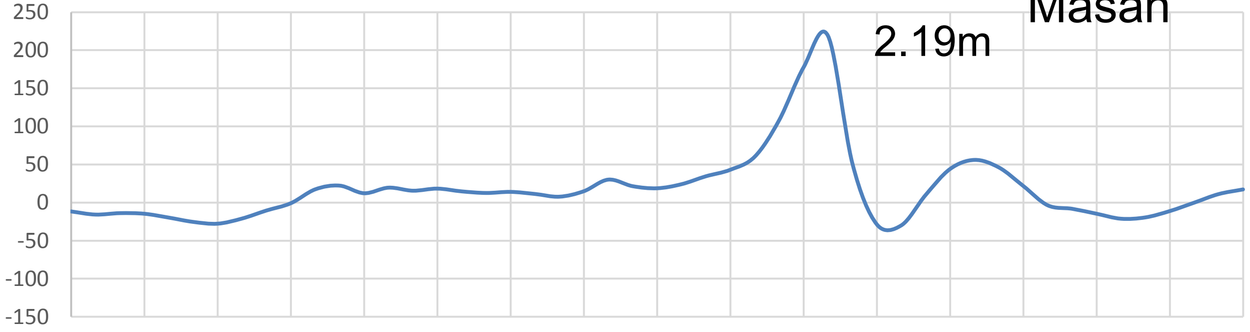


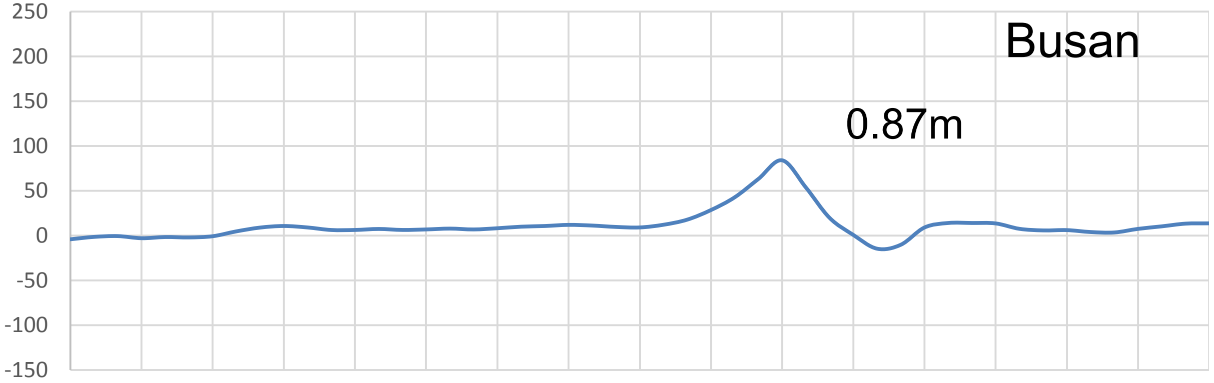
No data



Observation data to storm surge

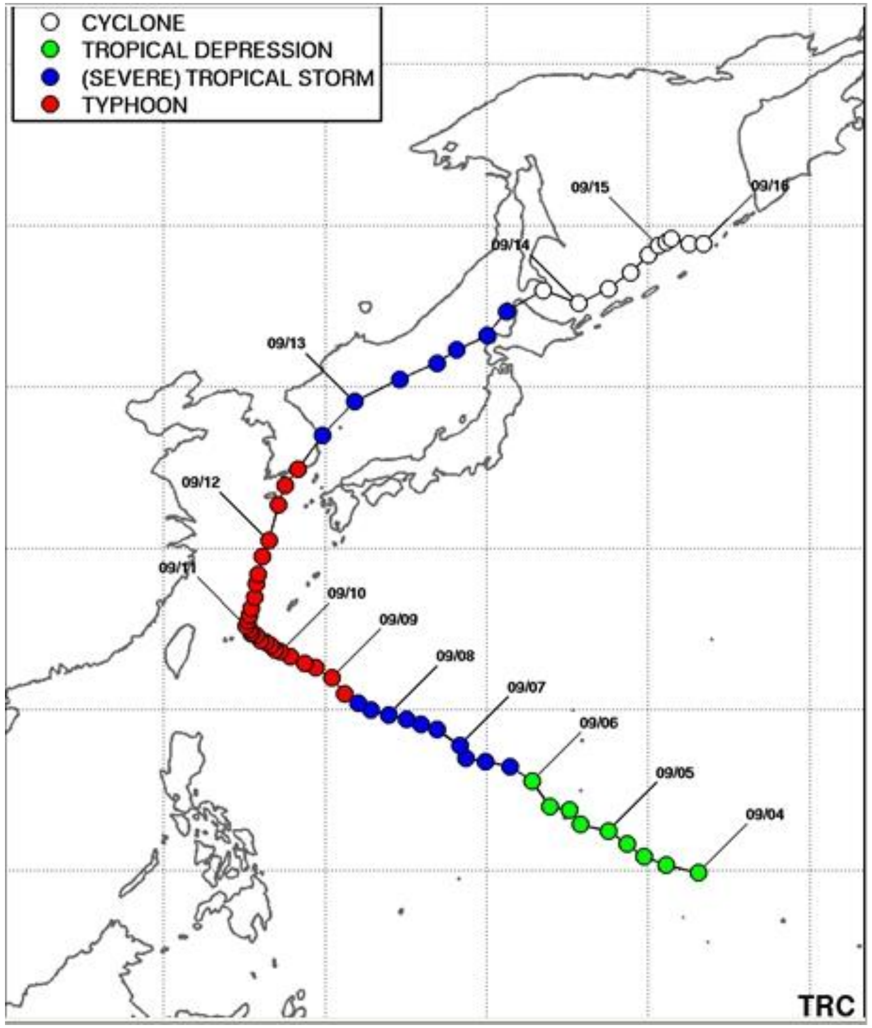




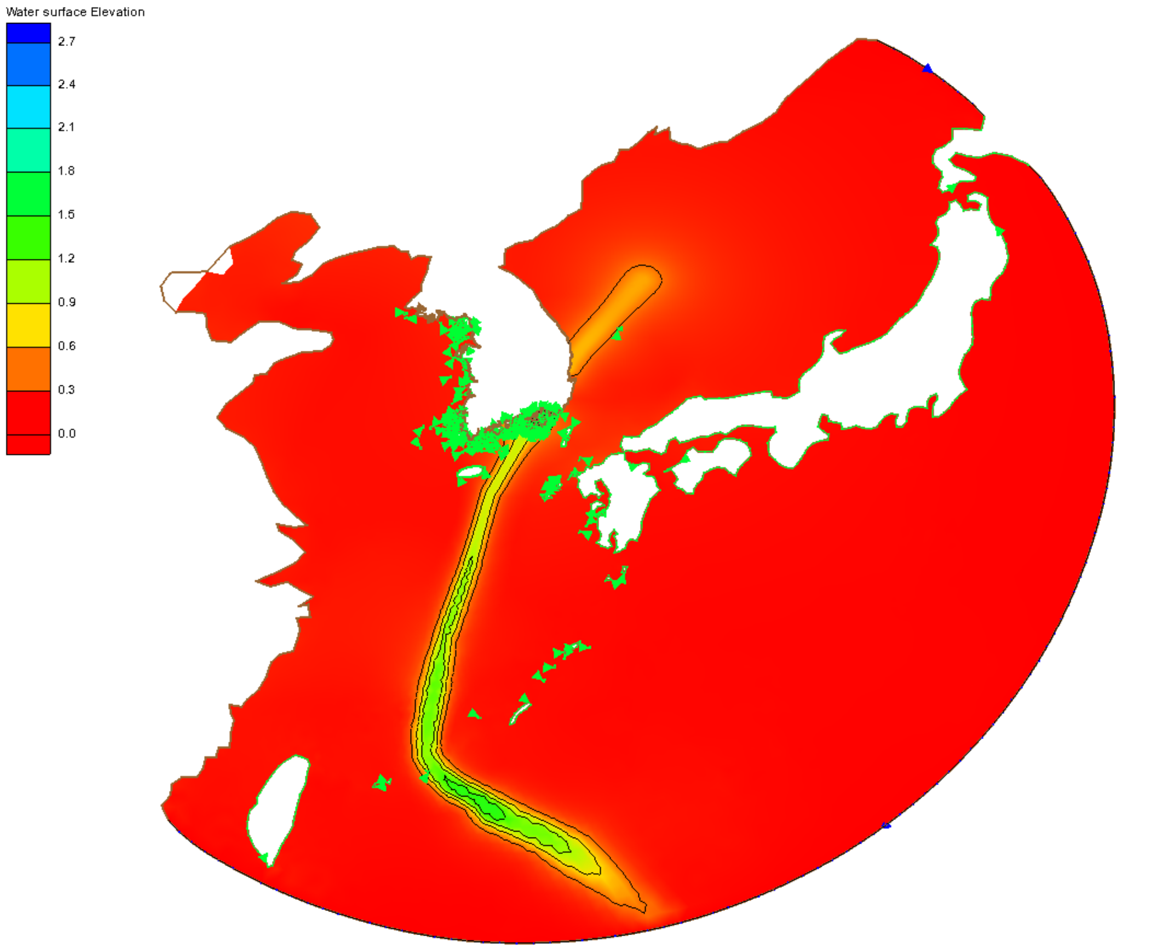


Results

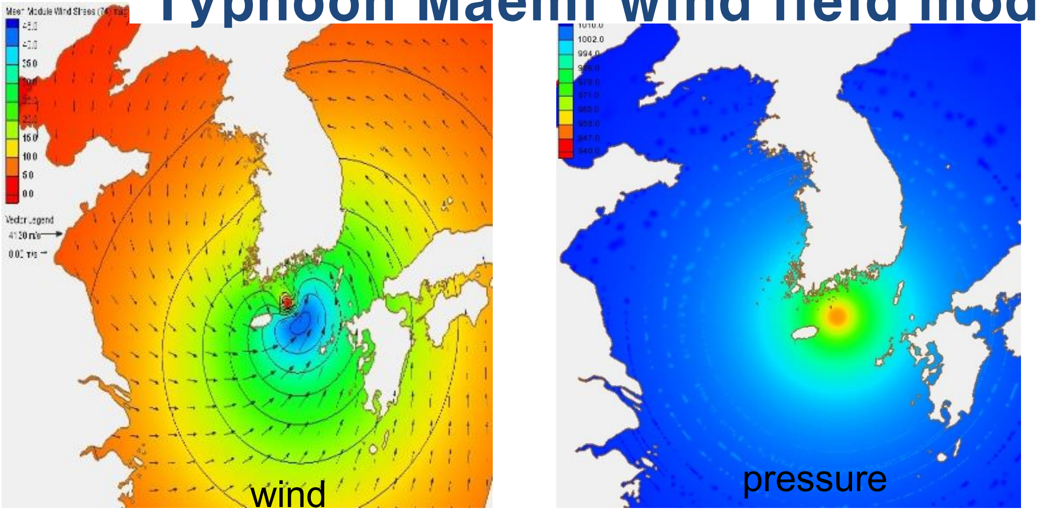
Storm surge



Maximum Storm surge field



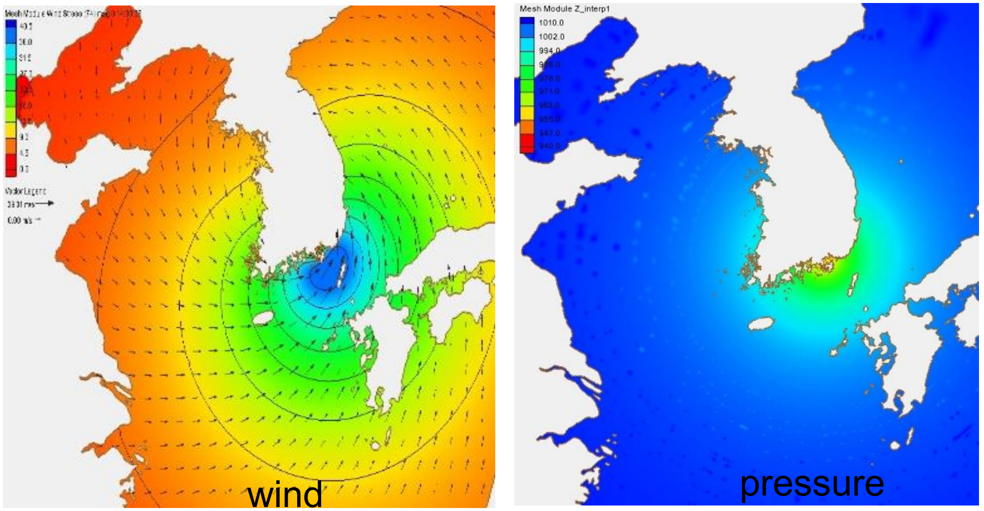
Typhoon Maemi wind field model



2003-09-12-18:00

Track of typhoon Maemi and wind field

Wind,pressure parameter : Radius of maximum wind speed(r_{max}), center of pressure(p_c), Maximum wind speed(V_{max}), Track of typhoon(lat,long)



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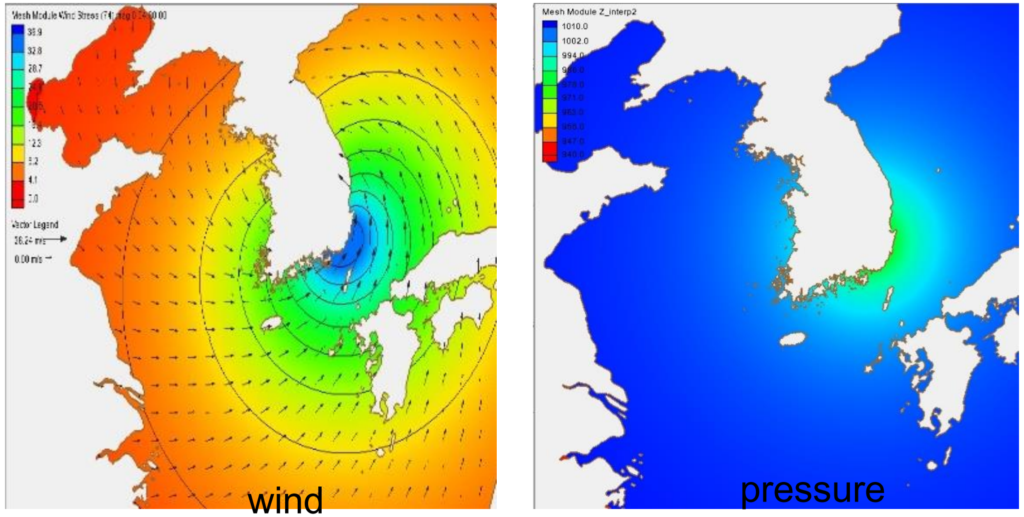
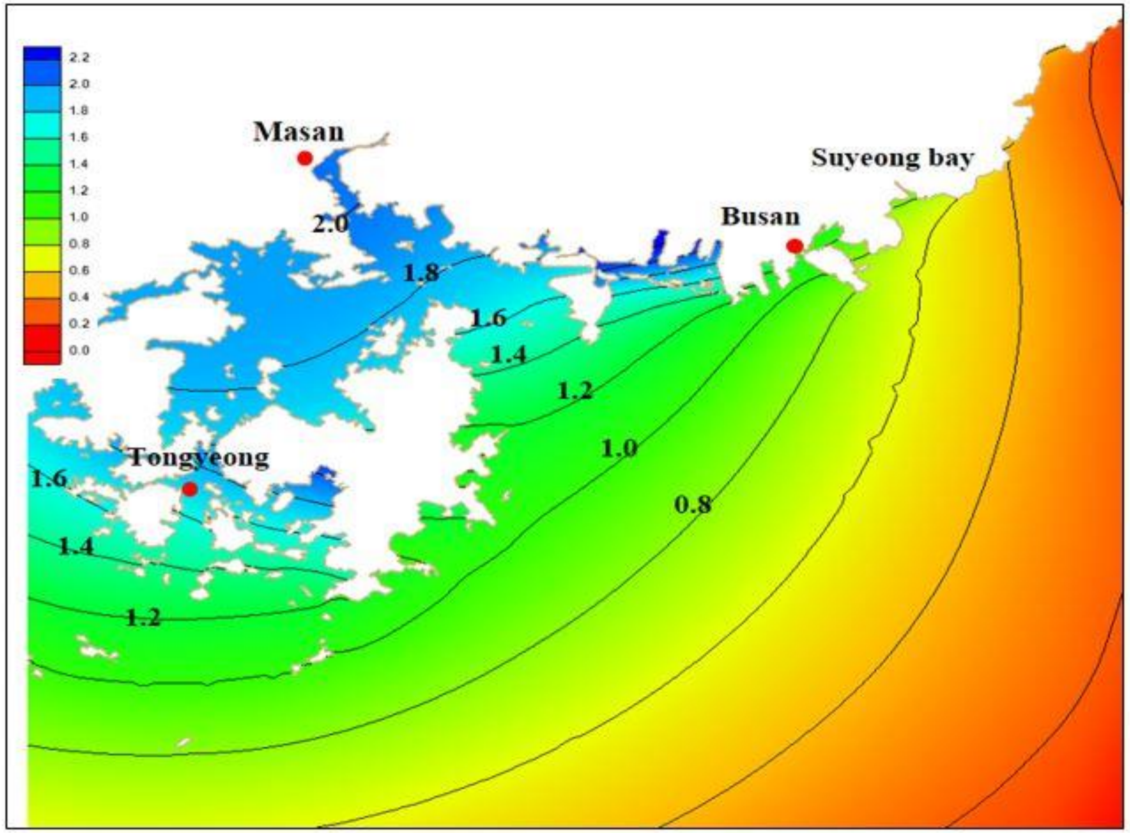


2003-09-12-13:00

The weather data condition of ADCIRC was set as NWS 5. After obtaining the weather data such as the wind velocity W(x), W(y), and atmospheric pressure on the nodal points of the entire subject area, fort.22, the input file was created.

Storm surge

- For the validation of numerical models, ADCIRC and observed data compared. Observed data at three tidal observation: Busan and Masan, Tongyeong.
- There show good agreement between the ADCIRC simulated and tidal observation data.



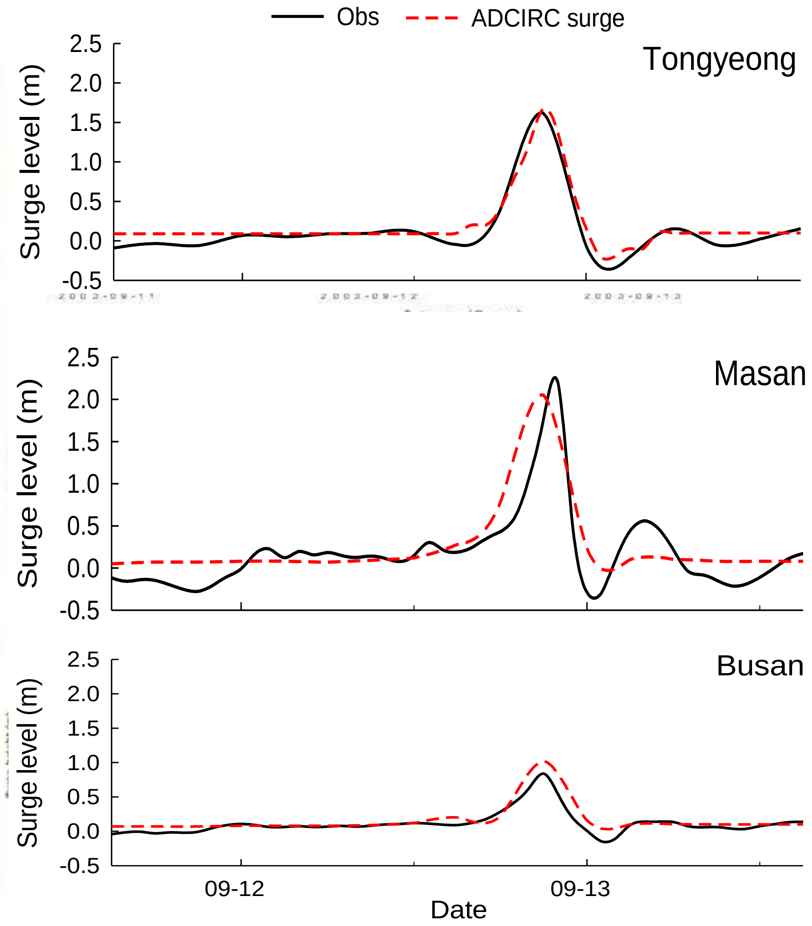


Fig. 6. Time series of maximum surge elevations

Comprehensive Results

- Considering the tide, storm surge, and river discharge, the water level fluctuations near Suyeong River at 21:00 on September 21, 2003, were analyzed.

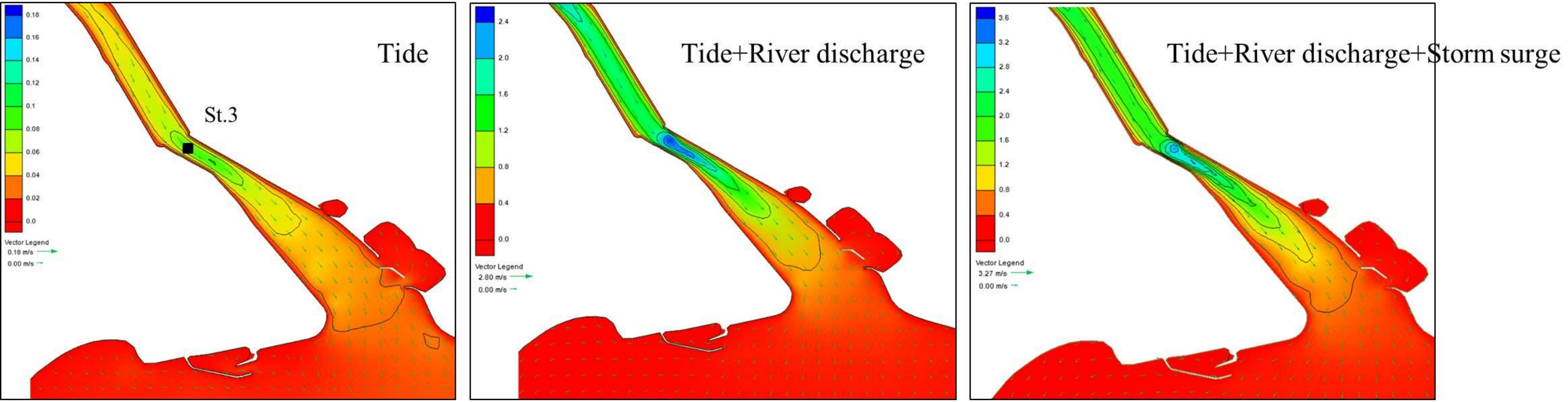


Fig. 7. Simulation of Velocity at inlet

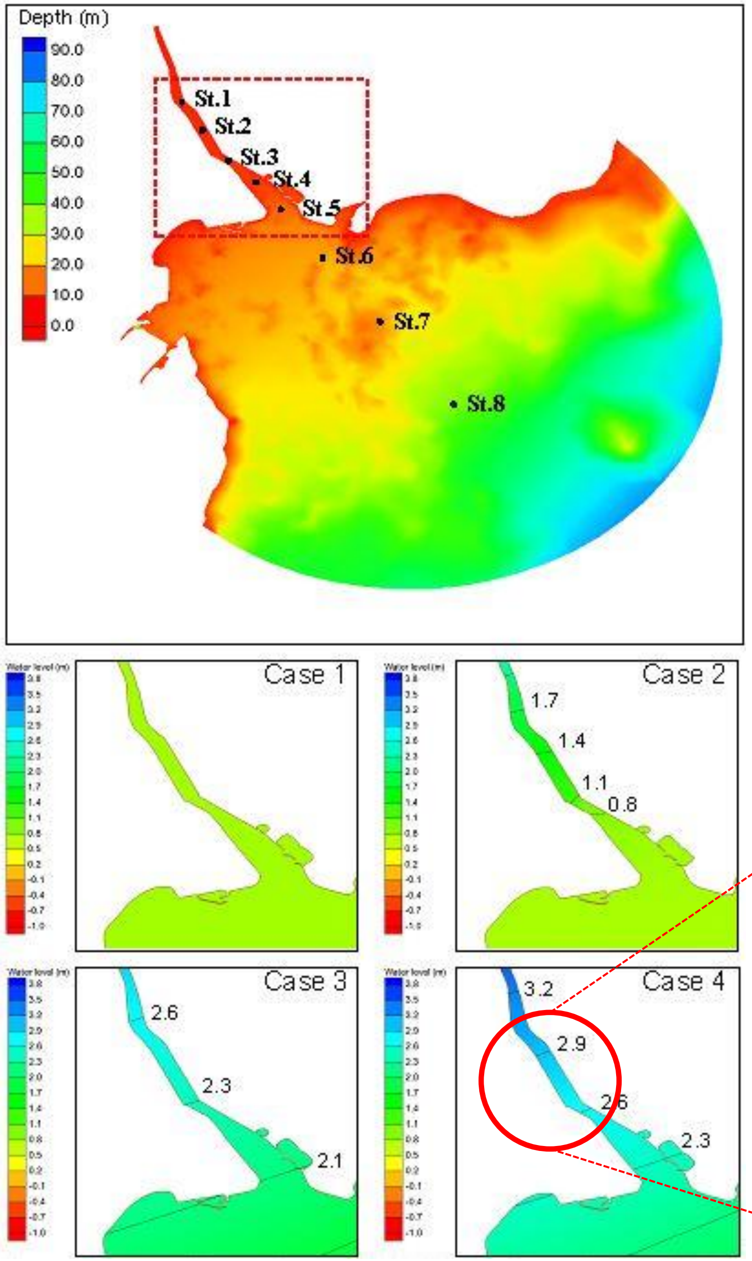
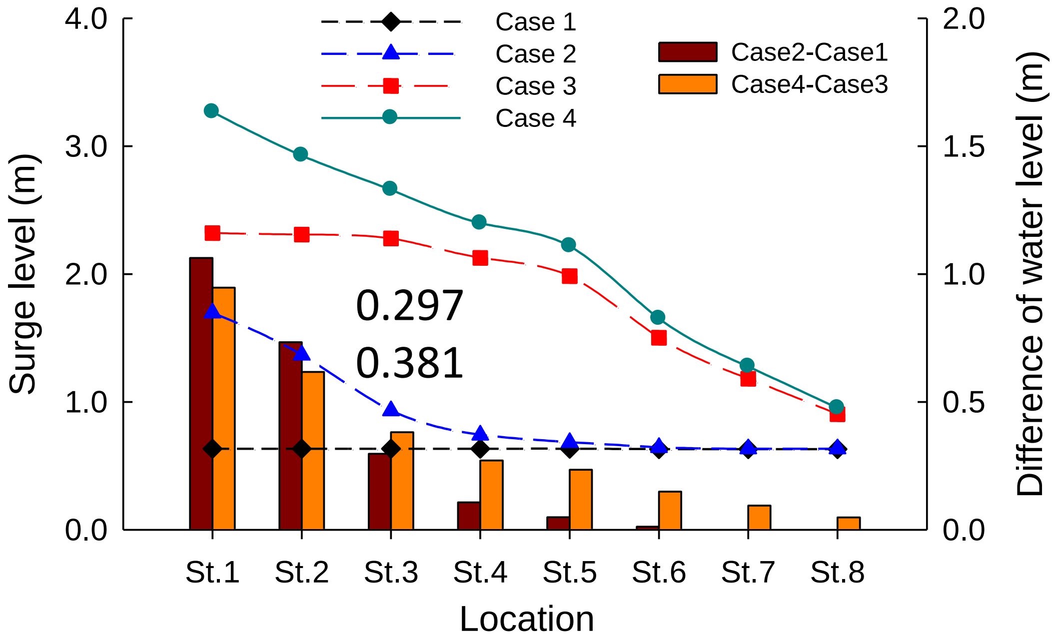


Fig.8. Images of water levels at Cases



Case(St.3)	Water Level(m)
Case 1 (Tide)	0.634
Case 2 (Tide+River discharge)	0.931
Case 3 (Tide+Storm surge)	2.278
Case 4 (Tide+Storm surge+River discharge)	2.659

Fig.9. Water Level Fluctuations by Simulation cases

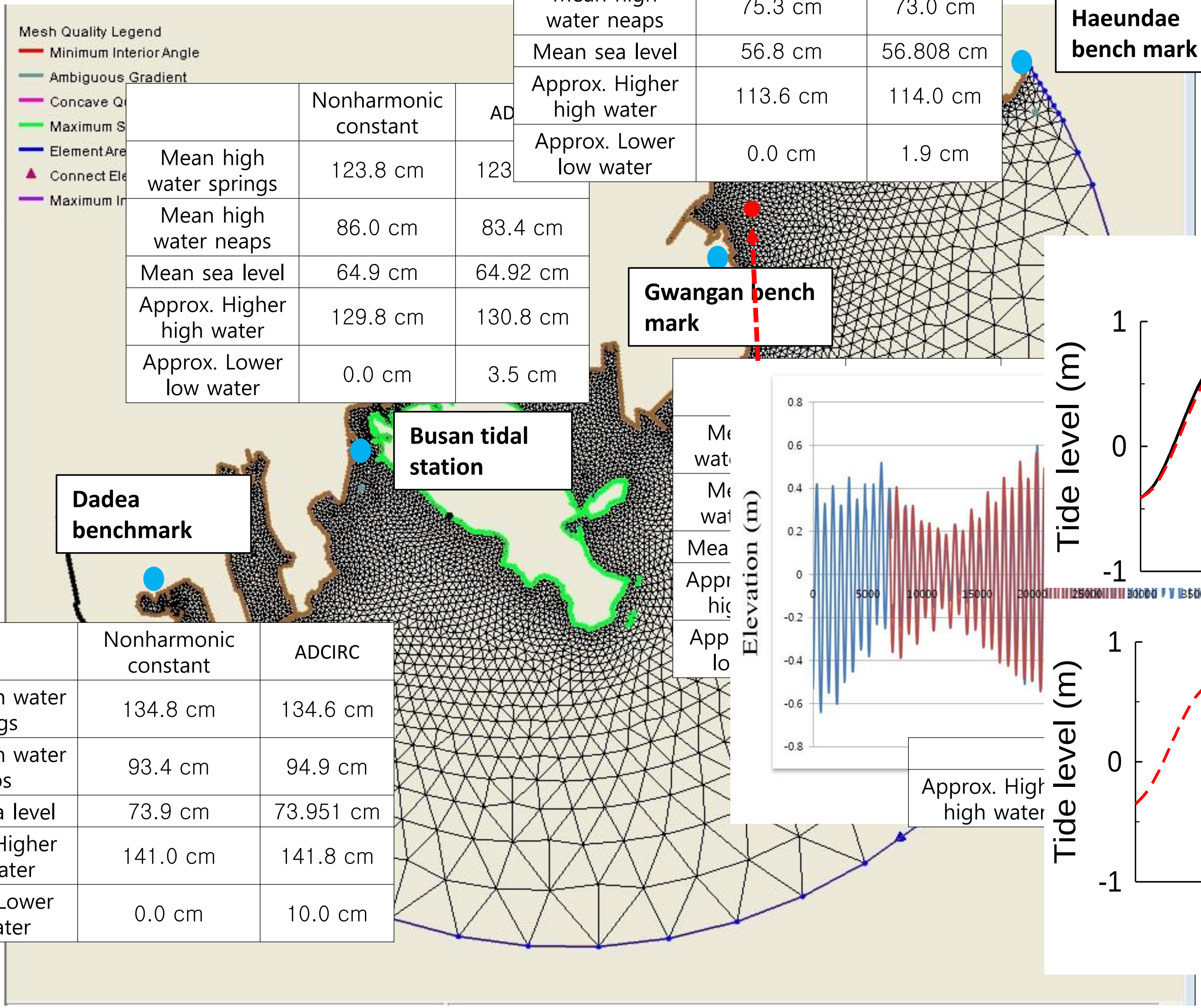
Fig.10. Inundation vulnerability in inlet-coastal area

Conclusions

- This study was examined for the vulnerability of river mouth by water elevation combined river discharge and storm surge.
- The influence of storm surge and river discharge is over 0.30m more than without river discharge.
- Interaction of river discharge and storm surge in coastal-inlet area is essential for assessment with water safety and useful to make safety index.

Thank you for your attention

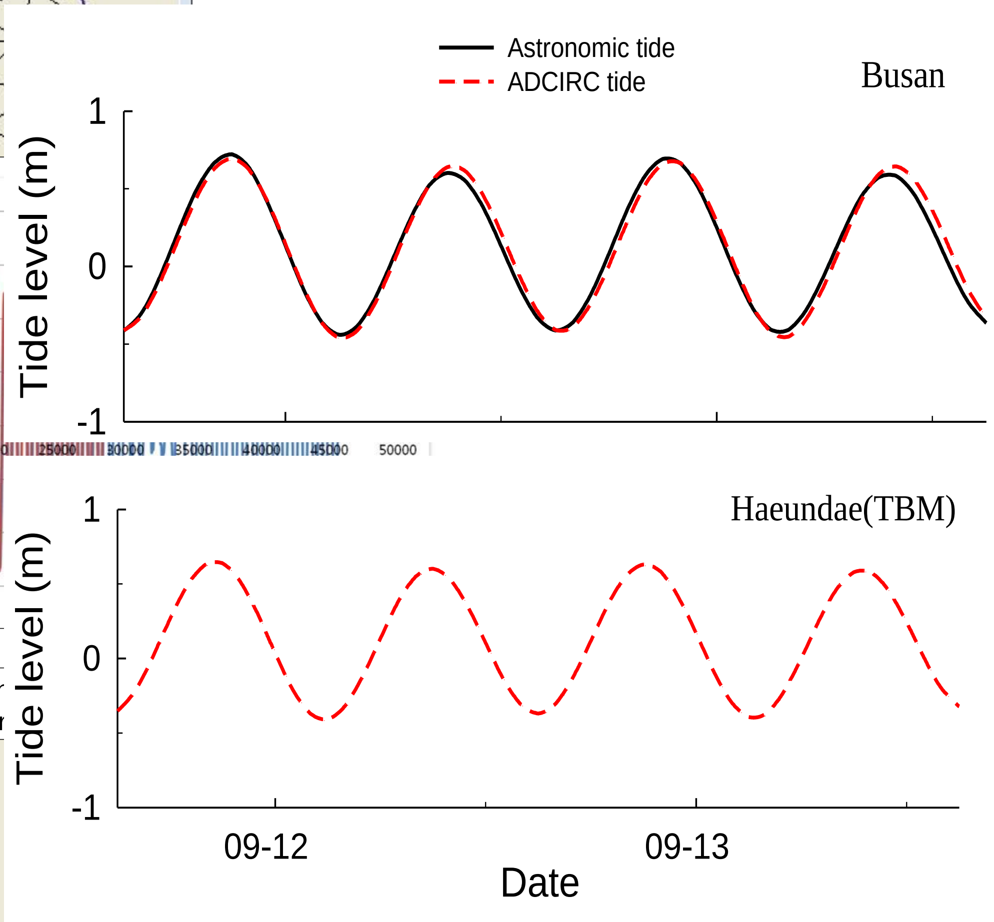
3. Result
Tide verification



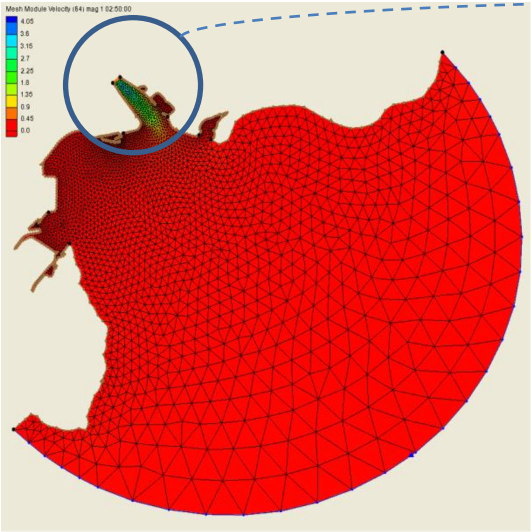
	Nonharmonic constant	ADCIRC
Mean high water springs	108.9 cm	106.0 cm
Mean high water neaps	75.3 cm	73.0 cm
Mean sea level	56.8 cm	56.808 cm
Approx. Higher high water	113.6 cm	114.0 cm
Approx. Lower low water	0.0 cm	1.9 cm

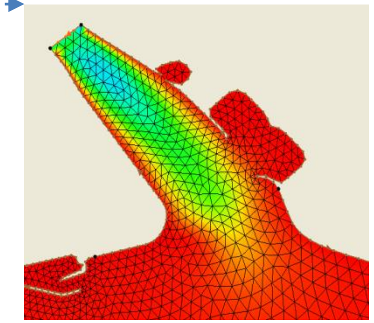
	Nonharmonic constant	AD…
Mean high water springs	123.8 cm	123…
Mean high water neaps	86.0 cm	83.4 cm
Mean sea level	64.9 cm	64.92 cm
Approx. Higher high water	129.8 cm	130.8 cm
Approx. Lower low water	0.0 cm	3.5 cm

	Nonharmonic constant	ADCIRC
Mean high water springs	134.8 cm	134.6 cm
Mean high water neaps	93.4 cm	94.9 cm
Mean sea level	73.9 cm	73.951 cm
Approx. Higher high water	141.0 cm	141.8 cm
Approx. Lower low water	0.0 cm	10.0 cm



River discharge





Q=1130m³/s