Storm Surge Response to Freshwater Outflow in the Ibaraki Prefecture before and after Typhoon Kirogi

*Josko Troselj[1], Nobuhito Mori[1]

1. Coastal Engineering Laboratory, Disaster Prevention Research Institute, Kyoto University

Introduction and Objective

Collaborative results (Troselj et al., 2017) have permitted for the first time to quantitatively evaluate the influence of extreme freshwater outflow to the coastal Ocean due to typhoon passage by combining River and Ocean models using hourly time step data and remote-sensing technology. They found that projection of coastal Sea Surface Salinity was improved (up to 10 PSU difference) and became more realistic with included freshwater impact and concluded that extreme events freshwater outflows significantly affect (decrease) Sea Surface Salinity distribution in the coastal zone.

With the advance of weather forecasting systems, and specific availability of forecasting typhoon trajectory and intensity, the research team aims to be able to apprehend freshwater impacts on the coastal marine environment in advance of typhoon events, and contribute greatly to the comprehensive management and protection of coastal areas.

One way how the previous study was followed up is presented here. As parameters which affect the total water level are storm surge, tides, waves and freshwater impact, the main objective of the study is reanalysis of function dependence between storm surge heights and the freshwater impact before and after Typhoon Kirogi (2000) in the Ibaraki Prefecture, Japan.

Methods

We used lateral boundary conditions of velocity, temperature and salinity from FORA-WNP30 parent dataset (10 km scale) downscaled by COAWST model using 3 domain nesting with 2 km, 600 m and 200 m scales respectively, for targeted reanalysis period of 2000.

Surface boundary conditions of wind speed, sea level pressure, air temperature, precipitation, shortwave radiation flux and cloud fraction are used from JRA-55 dataset, while forcing conditions are used as observed temperature and discharge with constant salinity of 0.5 PSU from Tone, Naka and Kuji rivers.

Discussions

We compared coastal storm surge heights for cases with and without freshwater outflow impact and discussed differences in results. We found presence of so called after-runner storm surge occurring about 3 days after passage of the event when river’ s flow hysteresis curve is at descending stage, which is known as a river flow mechanism when the same discharge values correspond to bigger water level values than at an ascending stage. The after-runner storm surge heights were smaller than more of 20 cm in

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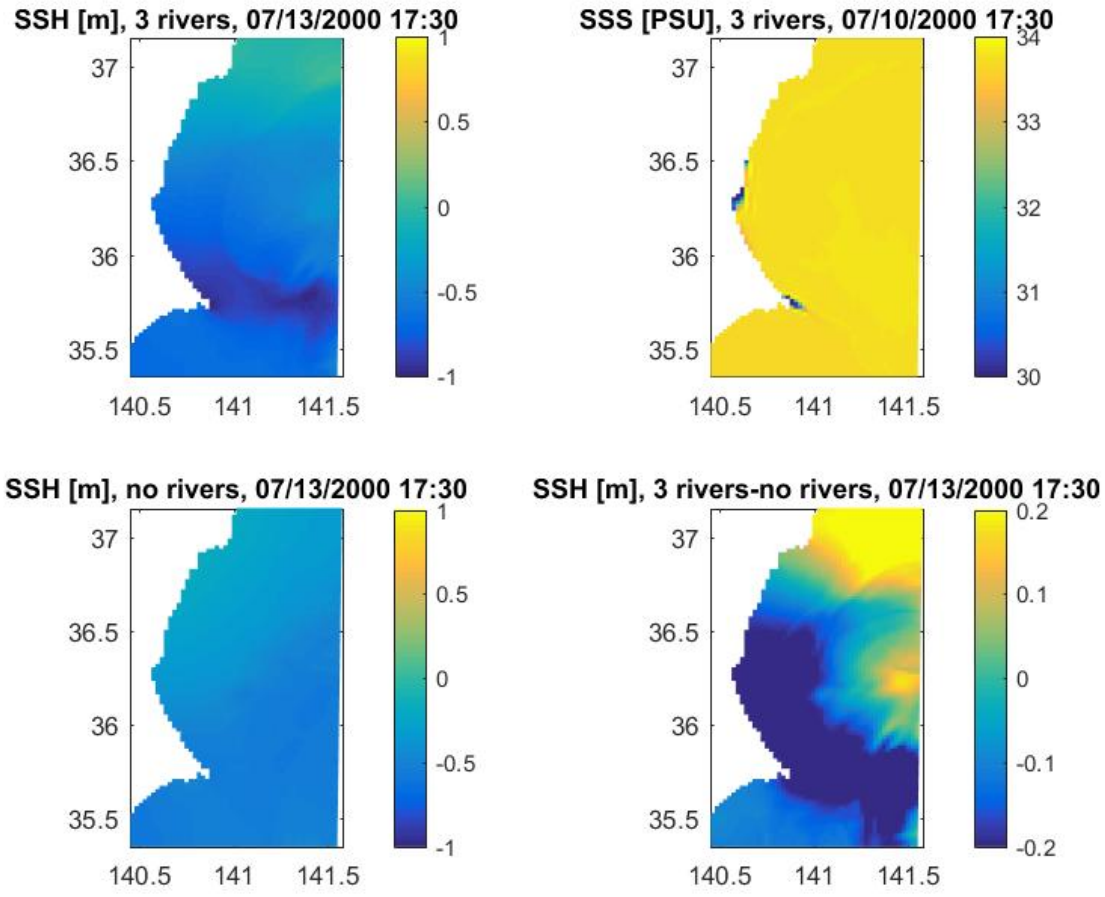
coastal zones near three rivers' mouths but bigger for more than 20 cm in offshore zones when compared to storm surge levels in the simulation without freshwater outflow impact included (shown in attachment).

Conclusions

Following the previous study, we have applied similar approach with using the COAWST oceanographic model and we found that the freshwater outflow impact to the storm surge is negligible during the typhoon passage but is important to be considered in evaluating an after-runner storm surge mechanism. This should be confirmed further in future works, by testing the applicability of using the same method with many other extreme typhoon event cases and with further validating the results with observations.

Reference: Troselj J, Sayama T, Varlamov SM, Sasaki T, Racault M-F, Takara K, Miyazawa Y, Kuroki R, Yamagata T, Yamashiki Y (2017). Modeling of extreme freshwater outflow from the north-eastern Japanese river basins to western Pacific Ocean, Journal of Hydrology, Vol. 555, pp. 956-970, doi:10.1016/j.jhydrol.2017.10.042

Keywords: storm surge, freshwater impact, extreme typhoon event, downscaling, coastal current, COAWST



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