A prediction of storm surge using the artificial neural networks (ANNs) based on a JTWC best track and tide-surge model

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There is huge damage caused by tropical typhoons every year in the South Korea. The storm surge due to landing of typhoon leads to severe flooding and casualty damage in coastal areas. Generally, the storm surge height is defined as the difference between the sea levels observed and predicted considering tide only. This advancing surge combines with the normal tides to create the typhoon storm surge height, which can increase the mean water level from only 1 to more than 2 m by the typhoon characteristics in Korea.

To efficiently describe the phenomenon of storm surge in the coastal area, many researchers have used the numerical model of fluid dynamics. However, recently, research activities based on not the numerical model but big data have gotten a lot of attention and the Artificial Neural Networks (ANNs) among these activities have shown powerful pattern classification and pattern recognition capabilities. The ANNs provide an attractive alternative tool for both forecasting researchers and practitioners. In particular, the ANNs have been widely applied to various areas to overcome the nonlinear natural disaster problems.

This paper is aimed to propose the application of the ANNs for prediction of the storm surge. Many storm surge data stored for a long time are required to predict storm surge accurately using ANNs. But, because of the lack of storm surge data in the past years, we calculated storm surges due to 53 typhoons which had affected the South Korea from 1978 to 2014 using a finite element tide-surge model (ADvanced CIRCulation Model) and the typhoon information of JTWC (Joint Typhoon Warning Center).

Factors such as the six hourly best track data of typhoon, head direction and velocity of typhoons, maximum sustained wind speed, minimum sea level pressure, radius of the last closed isobar, and radius of max winds were used to test the accuracy of the suggested ANNs model.

The normalized root mean squared error (RMSE) and correlation coefficient (CC) were used for the assessment of ANNs's prediction performance at Incheon, Gunsan and Mokpo national observation tide station in Korea (KHOA, Korea Hydrographic and Oceanographic Agency) and were applied to test the performance of this model. This paper shows that the neural networks can be efficiently and promptly predict storm surge based on typhoon information.