

## Study on the Characteristics of Storm Surge over Taiwan Eastern Waters by Wavelet Transform

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### ABSTRACT

This paper adopts wavelet transform to study the phenomena of storm surge based on the observed tidal data. The characteristics of space and frequency distributions of this feature can be revealed by wavelet energy. This analysis demonstrates when weather conditions are stable, the changes of the wavelet energy deviation closes to zero. However, the wavelet energy of storm surge increases along with the typhoon approaching. If the wavelet energy frequency is less than  $1 \text{ day}^{-1}$ , the distributions of storm surge graph are similar to that of energy curve. Wavelet energy distribution of surge can therefore acquire accurately the time of the occurrence of max surge. Meanwhile, it can reckon the influential time of storm surge on shore from the variety of the wavelet energy.

**KEY WORDS:** wavelet transform, storm surge

### INTRODUCTION

Taiwan is located between the tropical and subtropical regions of the northwest Pacific Ocean. It is the path of the typhoon during summer. Generally speaking, there are 3 to 4 typhoons invade and attack Taiwan Waters in averaged through the years. However, the trend has increased in recent years.

The eastern water of Taiwan faces the Pacific Ocean directly, where the typhoon is activity over there. When the typhoon hit eastern Taiwan, it is able to generate storm surge due to the water level rising within the typhoon scope. And storm surge makes big damage over the coast area. Therefore, storm surge phenomenon over Taiwan waters is a major product of typhoon. The processes of change of this kind of storm surge wave motion have three steps which are forerunner surging, storm surge, and resurgence.

The forerunner surging is made by the typhoon swell approaching coast region in advance to make the increment of the slowness of water level. The storm surge along the coast water level is rapidly increasing due to the air pressure descend gradually due to the typhoon effect. The resurgence is a wave motion that typhoon storm surge remains later on. These phenomena can maintain a longer time, and the amplitude of

oscillation becomes smaller and is near go back to astronomy tide level.

Hsu (1998) studied the sea water level ringing caused by various typhoon routes based on the born location and path sorts of the typhoon from 1994 to 1997. The result displays the water level of storm surge is influenced by the following factors which are typhoon dimension, intensity, route, movement speed, and locally topography, water depth and astronomy tide level.

Cheng (2003) seek the relation between storm surge and typhoon characteristic and find out that the storm surge at coast is under the influence of typhoon parameters such as center pressure, movement speed, typhoon radius, and the distance to the station. The order of the storm surge over the eastern water is highly directed and closed to the distance between station and typhoon center. The result of Wu (2005) points out, the storm surge will reach the maximum under the condition that the typhoon hit land. The amplitude of storm surge is higher than that of adjoint area. The results from the model simulation also showed the storm surge over eastern water is dominated by the typhoon center pressure which called reverse pressure effect. The order of the storm surge induced by the wind stress factor is not important.

Tou et al. (1986) adopted the linear model to analyze the spectral of the storm surge over Victoria Harbor and found out that the spectrum revealed a narrow band during the tidal energy frequency range. For the energy spectral of  $2.3 \times 10^{-5} \text{ Hz}$ , it is accordance with the semi-diurnal tide. By making use of the analysis of frequency chart for the tide level from the historical data, it is able to understand the variation of low frequency tide and then to predict the starting time of the variation of the water level and the time of the ends.

The Fourier transform is generally used to study the tide data. Its result emphasizes the relation between the frequency and energy. This method can not obtain the energy distribution on the time domain. However, it is able to understand the distribution of spectral density and frequency energy in the time domain. The application of the wavelet theory is gradually widely used in recent years, for example: Jay and Flincham (1999), Luettich Jr. et al. (2002), Pancheva and Mukhtarov (2000), Flincham and Jay (2000), Chambers et al. (2002), Lims and Lye (2004), Huang (2005). Those researchers apply wavelet theory to analyze tide data which makes the judgment of the information easier.