

Numerical simulation of typhoon storm surge in the LUOYUAN Bay

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According to the statistics of China Marine Disaster Bulletin published in May 2018, from 2008 to 2017, around 100 billion financial loss happened in each year due to marine disasters. Over 80% loss was caused by storm surges. Further, unfortunately, the FUJIAN Province is a place they prefer to visit. The research area, the LUOYUAN bay, is located on the northeastern area of the FUJIAN Province, which was so inconspicuous that not so many researchers concerned the storm surges happened there. However, it brings demands of study with the increase of financial developments and people's settling down in this area. Therefore, this research started.

For studying the response of the sea level in this area to a storm, a high-resolution model with the ADvanced CIRCulation model (ADCIRC) was established first. It used unstructured fine grids, and the topography from electronic chart partially and coastline data with resolution 1:10000. By comparing the simulated water level with the observation, we can see that both match with each other quite well. Furthermore, via harmonic analysis and contrasting with previous studies, the accuracy of this model was verified.

Based on the model, some experiments were conducted to assess the response inside of the bay to different kinds of typhoon, primarily with different intensities on the north-south (N-S) moving path, and the northwest-southeast (NW-SE) moving path. Results are as follows. On the one hand, there are common features we can understand easily: the surge increases gradually with the strength of typhoons, and the peak-value surge can reach approximately 3 meters if a typhoon landed as a SUPER TYPHOON; the low pressure of a typhoon and strong wind will lead to a surge, and this surge would be more obvious when the typhoon passes near coastal areas; because of the cyclonic structure of a typhoon, it is easier for a typhoon that moves on an offshore path to induce the rising of water level on the southern part of bay than the northern part. On the other hand, there are also other findings that might be difficult to understand just by imagination: for the N-S path, there is a steep reduction of the sea level inside of the bay after the peak-value time. Such a rapid reduction of sea levels does not happen for the NW-SE path but for those in the southern area along the FUJIAN Province. By analyzing the data, we consider that wind direction and the shape of the bay would be the main reasons causing this phenomenon. Further, there is an oscillation in the sea level after peak-value time for the typhoon on the N-S path, and a larger reduction exists inside of the bay than the outside. Resonance between the different frequency of sea level changes, caused by various moving speeds of typhoons, and the local natural frequency of the bay might have some effects. We attempt to investigate resonance for the future study. The experiments with various parallel paths to the N-S path, as well as those parallel to the NW-SE path, also give similar results.

Keywords: Luoyuan Bay, typhoon, storm surge, marine disaster prevention and mitigation