ABSTRACT

This study estimated the storm surges due to 2013 Typhoon Haiyan and model typhoons having parallel tracks to Haiyan by using a parametric typhoon model and a one-layer non-linear long wave model on 2-km-long interval bathymetry in the middle-latitude zone of Philippines. The result showed that Haiyan’s storm surge reached 3–4 m at and around Tacloban located on Leyte Gulf. The storm surge was higher than seven major typhoons affecting Leyte Gulf between 1951 and 2013 before Haiyan. The model typhoons can cause a remarkable storm surge in a wide area in the zone.

KEY WORDS: Typhoon Haiyan; parametric typhoon model; storm surge; wave.

INTRODUCTION

On November 8, 2013, Typhoon Haiyan (hereinafter, T1330), named Yolanda in Philippines, crossed Leyte Gulf in east-central Philippines with a 895 hPa central pressure, and triggered disastrous storm surge flooding, in particular at Tacloban located on Leyte Gulf. The storm surge was higher than seven major typhoons affecting Leyte Gulf between 1951 and 2013 before Haiyan. The model typhoons can cause a remarkable storm surge in a wide area in the zone.

Unfortunately no tide record is available on the Leyte Gulf coast during the passage of T1330; however, field surveys (e.g. JSCE-PICE Survey Team, 2013) have confirmed on the coastal land that the flood water level had reached 3–5 m above the astronomical tide level. A numerical hindcast is necessary to understand the storm surge phenomena in detail. Moreover, it is remarkable that the typhoon central pressure was lowest since 1951 in the middle-latitude zone of Philippines. An intense typhoon like T1330 may appear again on the same and different tracks in the future. A storm surge risk assessment which assumes such a typhoon can play a key role to mitigate future disasters.

That is the background why this study hindcasted the storm surges of T1330, major typhoons affecting Leyte Gulf between 1951 and 2013 before T1330, and model typhoons having parallel tracks to T1330, by applying a parametric typhoon model and a one-layer non-linear long wave model on 2-km-long interval bathymetry in the middle latitude zone of Philippines. The study also simulated the wave field of T1330 by using SWAN. This paper is aimed at providing the preliminary simulation results and at encouraging the subsequent research and discussion from the T1330 event to potential ones.

SIMULATION MODELS

Parametric Typhoon Model

Sea surface pressure and wind fields of a typhoon are often estimated by using a 2D empirical typhoon model which requires several fundamental parameters, such as the central pressure, the typhoon forwarding speed, and the wind speed reduction coefficient. The model does not account the effect of local land topography on the wind field; however, fortunately no major high mountain approaches Leyte Gulf. Mesoscale models, such as MM5 and WRF, are recently becoming popular tools. They can describe local features in pressure and wind fields precisely; however, they tend to overestimate the central pressure of a very intense typhoon and require a 3D parametric model, named typhoon bogus. Considering the above-mentioned conditions, this paper adopted a parametric typhoon model as described below.

Sea surface pressure $p$ at a radial distance $r$ from the typhoon center is given by

$$p = p_c + \Delta p \exp \left( -\frac{r}{r_0} \right)$$  \hspace{1cm} (1)

where $p_c$ is the central pressure, $\Delta p$ is the pressure differential, and $r_0$ is the radius of maximum wind speed (Myers and Malkin, 1961).

Considering a typhoon forwarding effect, we may write the balance of the pressure gradient force, the centrifugal force, and the Coriolis force