PROBABILISTIC EVALUATION OF STORM SURGES IN SURUGA BAY EMPLOYING STOCHASTIC TYPHOON MODEL

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INTRODUCTION

Design procedure of coastal embankment in Japan compares tsunami height and storm surge height and employs higher value as a crown level. Estimation of tsunami or storm surge height is usually based on the historical maximum record or an assumed maximum value. Estimation of storm surge needs not only typhoon intensity but also its characteristics e.g. tracks and travel speed. It is difficult to estimate the probability of storm surges using only observed data since typhoon rarely attacks particular area and storm surges are seldom generated. This study proposes probabilistic evaluation procedure of storm surges employing stochastic typhoon model and applies to Suruga Bay, Japan.

STOCHASTIC TYPHOON MODEL

Typhoon tracks passed the target area are extracted from synthetic typhoon track data set for 5000 years generated by the stochastic tropical cyclone model (STM) (Nakajo, et al., 2014). Characteristics of typhoons which passed within the area of radius of one degree from Suruga Bay are extracted. Minimum central pressures of extracted 4887 typhoons are analyzed and frequency distribution are estimated as show in Fig. 1. Observed typhoon data from the database by National Institute of Informatics are also analyzed and performance of STM are confirmed. Average numbers of typhoons which pass the target area become 0.8 per year for the observation while 0.9 per year for STM.

ESTIMATION OF STORM SURGES

Since total number of target 4887 typhoons is too many, storm surges are calculated by an empirical formula which was used by the Japan Meteorological Agency till 1998. Although estimation of storm surge by the empirical formula needs little computational cost, storm surge heights by the empirical formula are tend to be underestimated. Thus, storm surge simulations are additionally conducted by the nonlinear shallow water model (Kim, et al., 2008) for top 100 strong typhoons. Occurrence probabilities of storm surge height are estimated along the coast in Suruga Bay.

RETURN PERIOD

We consider that occurrence of storm surge follows the Poisson distribution and estimate recurrence probability. Hazard curves which is annual exceedance probability are estimated for 42 regional areas along the coast of Suruga Bay as shown in Fig. 2. Storm surge height of 1000-year return period (0.001) exceeded 1 m in all target area. The coasts facing southeast have larger storm surge height. The present design storm surge height in Suruga Coast is 0.98 m: design tide level from datum is 1.66 m and average spring tide is 0.68 m. Statistical analysis estimated a return period of the design storm surge height (0.98 m) is about 270 years. By using the figures and approximate equations obtained here, it becomes possible to estimate the return period of storm surge in Suruga Bay, and conversely, estimate the storm surge height with respect to the set recurrence probability.

CONCLUSIONS

This study employed the stochastic typhoon model to estimate the relationship between the magnitude of storm surges and the occurrence probability along the coast of Suruga Bay. The estimated hazard curves of storm surge can estimate the return period of the design storm surge in each regional coast. The proposed method can be applied to other areas.

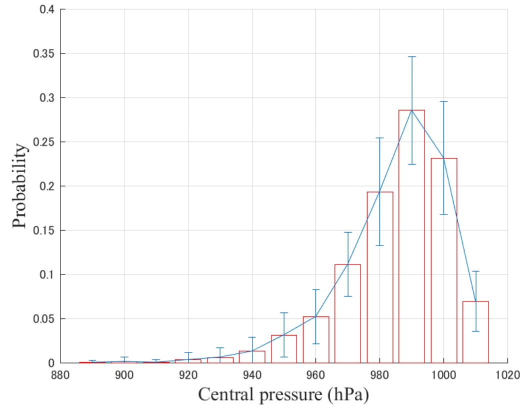

Figure 1 – Frequency distribution of minimum central pressure of typhoons in the target area estimated by the stochastic typhoon model (every 50 years; bar shows STD)

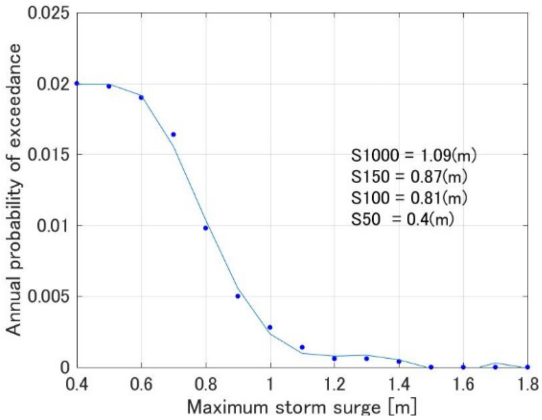

Figure 2 – Estimated hazard curve of storm surge in one of the 42 regional coasts (Suruga Coast)

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