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Lessons Learned from Recent Storm Surge Disasters for Performance Evaluation of Coastal Defense

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BACKGROUND

In 1959, Typhoon Vera has made landfall on Japan and triggered storm surge flooding with a loss of approximately 5,000 lives. Then the government began to construct long coastal defense covered with concrete, for the design storm water level including the storm surge of the typhoon. We understand that such the storm water level appears very rarely, but the IPCC 4th Reports warned us of future mean sea level rise and tropical cyclone intensification. That is a reason why we need to evaluate the performance of the aged coastal defense and to begin the discussion on climate change adaptation plans.

OBJECTS

This paper reviews the lessons learned from some recent disasters due to unexpected storm surge and/or waves and also verifies the long-term change in wave storm surge characteristics. Then the paper describes on the current knowledge and future necessary works, on the evaluation of the safety degree of the coastal defense under the current and future climates.

METHODS AND RESULTS

In 1999, Typhoon Bart gave the most enormous disaster in Japan since 1959. The coincidence of the storm surge with a spring high tide introduced that impulsive waves acted on the seawall crest over wave-dissipating blocks, successive waves scoured the foundation, and the seawall collapse permitted much wave-overtopping and/or overflowing water. Some aged persons were drowned in one-storied houses on low-lying ground. In 2004, ten typhoons, more than three times the normal, made landfall on Japan. One of them gave damage at a location, and the next one accumulated damage there before the recovery of the coastal defense.

The Nationwide Wave Information Network for Ports and Harbours, Japan was established in 1970 and is now measuring waves at 72 locations over Japan. According to the statistics, the frequency of high wave events due to typhoons and extra-tropical cyclones significantly increased at some locations, while the yearly-mean significant wave height is unlikely to have increased. The tide observation and storm surge numerical hindcasting indicates that severe storm surges frequently occurred in 1950-1960's and 1990-2000's.

Stochastic typhoon model, simulating various typhoon track and intensity with Monte Carlo method, is one of convenient tools to evaluate extreme storm surges. The simulation gave the result that the return period of the current design storm water level is several hundred years or more at three major locations Tokyo, Nagoya, and Osaka and is shorter at rural locations. The return period may decrease by future mean sea level rise and typhoon intensification, especially at the end of the bays.

CONCLUSIONS

The performance evaluation technique of coastal defense should be improved, especially for the destruction process, which is triggered by an unexpected event over the design and is accumulated by a moderate event after the destructive event. The long-term change in extreme wave and storm surge characteristics should be verified more carefully. The sensitive analysis on the uncertainty in the stochastic typhoon simulation is also necessary.