STUDY ON EXTREMELY LARGE STORM WAVES, SURGES AND CURRENTS AROUND THE EASTERN COAST OF HAINAN ISLAND

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OBJECTIVES

Extreme waves, strong currents and high surges are primary disaster-causing factors. In coastal engineering designs, it is crucial to consider the combinations of extreme waves, currents, and surges, which typically occur during extreme weather events such as typhoons. Based on the analysis of more than 500 historical tropical cyclones on the eastern coast of Hainan Island, China, it was found that the disaster-causing factors do not occur simultaneously at the concerned location. The highest wave height did not appear in the event with the strongest current or the highest surge level. Therefore, this study aims to investigate the correlation between the extreme dynamic factors in the specific region.

METHODS

Taking the eastern coast of Hainan Island as the study area as the yellow pentagram marked in Figure 1, this research analyzes the occurrence of the highest wave, maximum storm surge and current velocity during cyclone events, along with their relationship with wind-related factors like storm landing points, paths, and intensity.

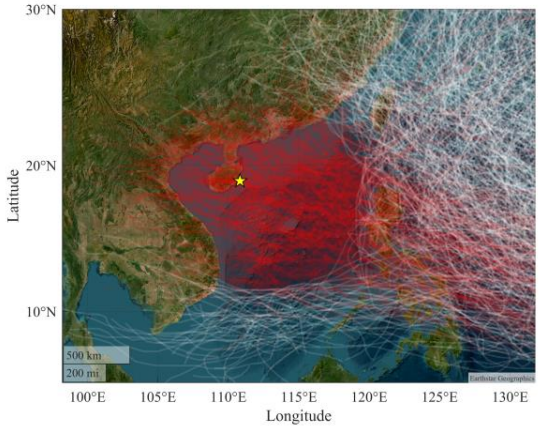

Figure 1 - Research area and cyclone paths (yellow pentagram marked the eastern coast of Hainan Island; lines in the diagram are cyclone paths, those have influenced Hainan Island are emphasized in red)

The present study collects data on a total of 526 cyclone processes occurring from 1959 to 2021, which had influenced on the eastern coast of Hainan Island. The waves, currents and surges during the historical events have been numerically reproduced by the widely-used wave action balance model SWAN (Zijlema, 2010) and the three-dimensional ocean dynamics model FVCOM (Chen et al., 2003). The driven wind and pressure fields of historical events are given by coupling the parameterized model wind field with ECMWF reanalysis datasets. The models have been validated using the data measured during the super typhoon Rammasun (No. 1409), typhoon Kalmaegi (No. 1415) and typhoon Chaba (No. 2203).

RESULTS

Several representative cases are chosen in the study, time points are screened when extremely high wave occurs at the location where the yellow pentagram marked in Figure 1, and a contraction on the storm surge, current velocity, wave height and wind strength is conducted in Figure 2. Through comparison on different events, a conclusion can be drawn that even though the disaster factors tend to increase with the escalation of wind strength, yet it does not mean that the strongest wind is accompanied by the largest current, surge and wave. For example, though Zeke (No. 9106) has the largest wave height among the selected events, its current velocity and surge are relatively smaller, while the wind strength is neither the strongest nor the relatively weakest among the selected events. No significant linear association exists among these factors.

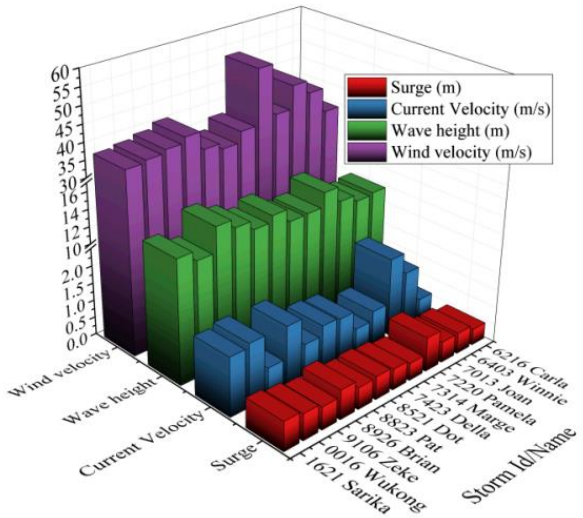

Figure 2 - Comparison of factors at Maximum Wave Height moment (the vertical axis shows only the magnitude of the values, the units are queried according to the legend)

Further correlation analysis of each disaster factor is conducted. Figure 3 illustrates the relativity between current velocity and wave height in Joan (No. 7013) and Zeke processes. Linear fitting lines are also calculated. Generally, stronger waves associate with stronger current during each event, as shown in the figure that

positive correlation can be clearly seen. Due to the complicate process of typhoon, there is a strong divergence of the fitting lines in different events, and the slops vary a lot. Furthermore, the relativity of other factors is studied, and the bias of linear estimation is concluded.

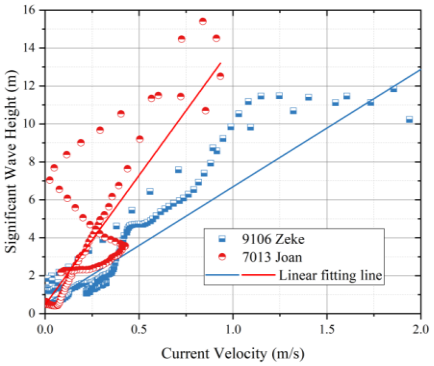

Figure 3 – Corresponding of wave height with current velocity during two typical typhoon events

CONCLUTION

The disaster-causing factors in coastal designs show positive correlation but non-linearity characteristics. By reproduction of historical extreme events, the relationship of surge, current, wave and wind is studied, the bias of linearity fitting among the factors is summarized.

REFERENCES

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