Correlation between Tsunami Height and Strong Ground Motions

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When a large earthquake occurs off a coast, the resulting ground motion can soon be followed by the arrival of tsunami waves. This interrelationship can be useful for issuing tsunami alerts. This study aims at detecting correlative relationships between the intensity (runup) of a tsunami at a site along the coast and ground motion parameters at the same site due to the earthquake that produced the tsunami. Our estimates were derived by combining historical and instrumental data for eight sites along the Pacific coast of Japan (Figure 1).
Our regression analysis of collected and systematized data used the tobit model, which is able to incorporate all tsunami data, including censored data below the tsunami-detection threshold. We show that if such tsunamis are neglected by the standard regression model, the result is to overestimate the height of predicted tsunamis (Figure 2).
Analysis of the regression results (Figure 2) shows that when a tsunami generating-earthquake has occurred, a tsunami with runup that is equal to or greater than 50 cm should be expected if peak ground motion velocities greater than 7 cm/s have been recorded at the same site, with the probability of the failure to predict being 16%.
However we should notice that large standard deviation of data, around +/- 4 times, results in large percent of false alarm cases and makes practical prediction problematic. In order to analyze possible reasons of such a large scattering of data, we grouped them according to type of ground condition, shore line and earthquake source. It is found that effects of ground conditions and shore line are minor in comparison with tsunami-genic effect of particular source.
Acknowledgments. Data from databases of next institutions and agencies are used: IVMiMG, NOAA, NIED, JMA, PARI, Tohoku Univ. We are grateful to T.V. Shkinder for help with Japanese text sources.
Figure 1. A map of the study area. The triangles mark the selected sites with copious data, with a number of observations of 20 or more. The inclined crosses mark the epicenters of earthquakes analysed.
Figure 2. A summary of tobit regression for individual sites (light lines) and for all of the data at the eight sites combined (long-dashed line). The short-dashed line shows the mean plus standard error for all of the sites combined. The heavy solid line is the mean for the standard regression without the censored data.

Keywords: strong ground motions, tobit regression, tsunami forecast

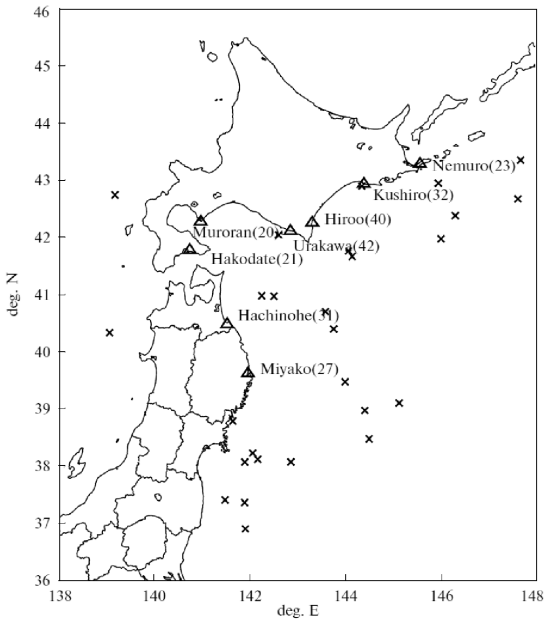

Figure 1

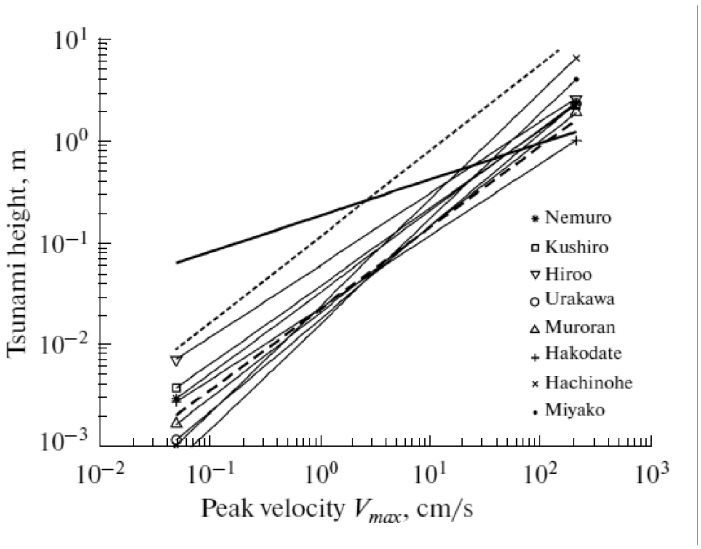

Figure 2

