

Conditional Probability Approach of the Assessment of Tsunami Potential: Application in Three Tsunamigenic Regions of the Pacific Ocean

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Abstract—We develop stochastic approaches to determine the potential for tsunami generation from earthquakes by combining two interrelated time series, one for the earthquake events, and another for the tsunami events. Conditional probabilities for the occurrence of tsunamis as a function of time are calculated by assuming that the inter-arrival times of the past events are lognormally distributed and by taking into account the time of occurrence of the last event in the time series. An alternative approach is based on the total probability theorem. Then, the probability for the tsunami occurrence equals the product of the ratio, r (= tsunami generating earthquakes/total number of earthquakes) by the conditional probability for the occurrence of the next earthquake in the zone. The probabilities obtained by the total probability theorem are bounded upwards by the ratio r and, therefore, they are not comparable with the conditional probabilities. The two methods were successfully tested in three characteristic seismic zones of the Pacific Ocean: South America, Kuril-Kamchatka and Japan. For time intervals of about 20 years and over the probabilities exceed 0.50 in the three zones. It has been found that the results depend on the approach applied. In fact, the conditional probabilities of tsunami occurrence in Japan are slightly higher than in the South America region and in Kuril-Kamchatka they are clearly lower than in South America. Probabilities calculated by the total probability theorem are systematically higher in South America than in Japan while in Kuril-Kamchatka they are significantly lower than in Japan. The stochastic techniques tested in this paper are promising for the tsunami potential assessment in other tsunamigenic regions of the world.

Key words: Tsunami potential, stochastic approaches, Pacific Ocean.

Introduction

The stochastic forecasting of strong tsunami occurrences in tsunamigenic seismic zones is of great importance for the development of reliable tsunami hazard assessment and risk mitigation strategies. However, no standard methodologies have been developed so far to forecast tsunami occurrences. Nevertheless, some statistical and probabilistic methods have been proposed and two main types of approaches can be recognized. The first focuses on the estimation of the recurrence of tsunami