Geophysical Research Abstracts
Vol. 15, EGU2013-8898, 2013
EGU General Assembly 2013

Probabilistic Tsunami Hazard Assessment from Incomplete Historical Catalogs with an Application in the Mediterranean Region

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The probabilistic tsunami hazard analysis requires observations that spans over hundreds of years. For many tsunami-threatened coastal areas, such long historic records are available, containing information about the largest and catastrophic tsunami occurrences. These records can, however, not be used by conventional procedures since they are highly incomplete. In this presentation we introduce a procedure which permits the assessment of the maximum likelihood estimates of the key parameters of the extreme tsunami distributions when the largest tsunamis are selected from consecutive, but not necessarily equal time intervals. In practice, such tsunamis are as a rule produced by large earthquakes. It has been shown that the tsunami intensity, K, follows a power-law distribution similar to the frequency-magnitude (G-R) relationship for earthquakes. In addition, we assume that K is truncated from the top by the coastline characteristic, maximum possible tsunami intensity, Kmax. Then, the probability distribution function of K are easily formulated. In our approach, K is considered as a continuous variable that may assume any value between Kmin and the coastline characteristic, the maximum possible tsunami intensity Kmax. In addition, it is assumed that the distribution of the number of tsunamis observed along a stretch of coastline within specified time interval follows the distribution of the number of earthquakes. Base on the above assumptions, the probability, that along a certain stretch of a coastline within specified time interval, t, the largest tsunami will not exceed the specified intensity K, was derived. The resulting extreme distribution of intensity K is truncated from both ends. The truncation from the left is Kmin, representing the chosen minimum value of intensity used in the calculation of the hazard parameters. The upper limit of intensity follows from the truncation of the parent distribution by an unknown coastline characteristic, the maximum possible intensity Kmax. If Kmax—> + , and t =1.0, the newly derived distribution takes the form of the first Gumbel distribution of extremes. In order to estimate the parameters of the extreme distribution for tsunamis (the mean activity rate λ, the β parameter of G-R, and Kmax), the largest intensities K=(K1,... Kn) are selected from n consecutive time intervals T=(T1,... Tn) and the respective maximum likelihood function of the random intensities is calculated. For the specified value of Kmax, the maximum likelihood estimates of the parameters λ and β are derived. The procedure for the assessment of the largest possible tsunami intensity is also presented. This procedure is applied to a tsunami catalog of the Mediterranean region in general, as well as in tsunami catalogs of selected tsunamigenic zones of the region, where intensity is expressed in the 12-grade Papadopoulos-Imamura tsunami intensity scale.