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Identification of submarine landslide tsunami sources: A probabilistic approach for the Gulf of Mexico

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The devastating consequences of recent tsunami events in Indonesia (2004), Japan (2011) have changed the perception about tsunami potential and have prompted a scientific response in assessing the tsunami hazard in regions even though an apparent low-risk or/and lack of complete historical tsunami record exists. Although a great uncertainty exists regarding the return period of large-scale tsunami events in the Gulf of Mexico (GOM), geological and historical evidences indicate that the most likely tsunami hazard could come from a submarine landslide triggered by a moderate earthquake. Under these circumstances, the assessment of the tsunami hazard in the region could be better accomplished by means of a probabilistic approach to include the uncertainty in the hazard analysis and thus to identify tsunami sources.

This study aims to customize for the GOM an existing probabilistic methodology to determine landslide-tsunami sources associated with return periods. The Monte Carlo Simulation (MCS) technique is employed to determine the uncertainty related to location/water-depth and landslide dimension based on normal/lognormal distributions obtained from observed data. Along fixed transects over the continental slope of the GOM, slide angle of failure, soil properties and seismic peak horizontal accelerations (PHA) are determined by publicly available data. These parameter values are used to perform slope stability analyses in randomly generated translational submarine mass failure (SMF) obtained from the MCS technique. Once the translational SMF is identified as tsunamigenic for a given recurrence rate, a preliminary tsunami amplitude can be estimated by using empirical formulations. Thus, the annual probability of a tsunamigenic SMF is determined by the joint probability with the annual PHA.

By using the probabilistic approach we identified tsunami sources associated with return periods from few thousands to 10,000 years for each fixed transects defined over the continental slope of the GOM.

Keywords: tsunami, submarine landslide, the Monte Carlo Simulation