Probabilistic tsunami hazard analysis (PTHA) of Taiwan region by stochastic model

Speaker: Yu-Sheng Sun Adviser: Chien-Chih Chen, Po-Fei Chen

We conduct probabilistic tsunami hazard analysis (PTHA) of Taiwan region for earthquake sources in the south part of the Ryukyu trench. The PTHA estimates the probabilities of a site hit by tsunamis with certain amplitudes threshold. The probabilities will be integrated over earthquakes of various magnitudes from potential fault zones in the Ryukyu trench. In the first instance, however, we prefer to comprehend the influence by maximum moment magnitude because we can define the limit of wave height by tsunami from this region. The annual frequencies of earthquakes in a fault zone are determined or extrapolated by magnitude-frequency distributions of earthquakes (Gutenberg-Richter law) of the zone. Given moment (or magnitude) of an earthquake, we first synthesize patterns of differently complex and heterogeneous slip distributions on the fault using stochastic model. Assuming the slip and stress drop distribution are processes of fractional Brownian motion and described by Hurt exponent. According to ω^{-2} model of earthquakes and following Fourier transform, slip distributions of earthquake are determined by randomly distributing phase spectrum of those with greater than corner wave number k_c. Finally, the vertical seafloor displacements induced by each slip distribution are used by COMCOT for simulation of tsunami to assess the impacts on various coasts in Taiwan. The probabilities of wave height show the gauges closed to source have higher uncertainty and approximately estimate the limit. The uniform slip rupture looks like an average situation in wave height distribution. This method is better and more realistic to estimate tsunami hazard.

Reference

Wu, T. R., Chen, P. F., Tsai, W. T., & Chen, G. Y. (2008). Numerical study on tsunamis excited by 2006 Pingtung earthquake doublet. Terr. Atmos.

Pacific Gas & Electric Company. (2010). Methodology for Probabilistic Tsunami Hazard Analysis: Trial Application for the Diablo Canyon Power Plant Site. Submitted to the PEER Workshop on Tsunami Hazard Analyses for Engineering Design Parameters, Berkeley CA.

Παπαζάχος, Β. Κ., Σκορδύλης, Ε. Μ., Παναγιωτόπουλος, Δ. Γ., Παπαζάχος, Κ. Β., & Καρακαϊσης, Γ. Φ. (2004). Global relations between seismic fault parameters and moment magnitude of earthquakes. Δελτίον της Ελληνικής Γεωλογικής Εταιρίας, 36(3), 1482-1489.

Kanamori, H., & Anderson, D. L. (1975). Theoretical basis of some empirical relations in seismology. Bulletin of the Seismological Society of America, 65(5), 1073-1095.

Kanamori, H. (1977). The energy release in great earthquakes. Journal of geophysical research, 82(20), 2981-2987.\

Hanks, T. C. Kanamori, H. (1979). A moment magnitude scale, J. Geophys. Res. 84, 2348- 2350.

Andrews, D. J. (1980). A Stochastic Fault Model, 1. Static Case, J. Geophys. Res. 85, 3867–3877.

Tsai, C. C. (1997). Slip, stress drop and ground motion of earthquakes: A view from the perspective of fractional Brownian motion. pure and applied geophysics, 149(4), 689-706.

Herrero, A., and Bernard, P. (1994), A Kinematic Self-similar Rupture Process for Earthquakes, Bull. Seismol. Soc. Am. 84, 1216–1228.

Lavallée, D., Liu, P., & Archuleta, R. J. (2006). Stochastic model of heterogeneity in earthquake slip spatial distributions. Geophysical Journal International, 165(2), 622-640

Okada, Y. (1985). Surface deformation due to shear and tensile faults in a half-space. Bull. Seismol. Soc. Am., 75, 1135- 1154.

Liu, P. L. F., Cho, Y. S., Yoon, S. B. and Seo, S. N. 1994: Numerical simulations of the 1960 Chilean tsunami propagation and inundation at Hilo, Hawaii. In: El-Sabh, M. I. (Ed.), Recent Development in Tsunami Research, Kluwer Academic, Dordrecht, The Netherlands, 99-115.

Liu, P. L. F., Cho, Y. S., Briggs, M. J., Kanoglu, U. and Synolakis, C. E. (1995) Runup of solitary waves on a circular island. J. Fluid Mech., 302, 259-285.

Wang, X. and Liu, P. L. F. (2005) A numerical investigation of Boumerdes-Zemmouri (Algeria) earthquake and tsunami. Comput. Model. Eng. Sci., 10, 171-184.

Wang, X. and Liu, P. L. F. (2006) An analysis of 2004 Sumatra earthquake fault plane mechanisms and Indian Ocean tsunami. J. Hydraul. Res., 44, 147-154.

Gutenberg , B. and Richter, C. F. (1944) B. Gutenberg, C.F. RichterFrequency of earthquakes in CaliforniaBull. Seismol. Soc. Am., 34 (1944), pp. 185–188

Geist, E. L. (2002). Complex earthquake rupture and local tsunamis. Journal of Geophysical Research: Solid Earth (1978–2012), 107(B5), ESE-2.