The Chile tsunami of 27 February 2010: Observations and modeling

H. M. Fritz (1), C. M. Petroff (2), P. A. Catalán (3), R. Cienfuegos (4), P. Winckler (5), N. Kalligeris (6), R. Weiss (7), G. Meneses (8), C. Valderas-Bermejo (8), S. Barrientos (8), C. Ebeling (9), A. Papadopoulos (7), M. Contreras (10), R. Almar (5), J. C. Dominguez (5), C. E. Synolakis (11,7)

(1) Georgia Institute of Technology, Civil and Environmental Engineering, Savannah, United States (fritz@gatech.edu), (2) LP4 Associates LLC, Mercer island, WA, (3) Departamento de Obras Civiles, Universidad Técnica Federico Santa María, Valparaíso, Chile, (4) Departamento de Ingeniería Hidráulica y Ambiental, Escuela de Ingeniería, Pontificia Universidad Católica de Chile, (5) School of Ocean Engineering, Universidad de Valparaíso, Chile, (6) Department of Environmental Engineering, Technical University of Crete, Chania 73100, Greece, (7) Department of Geosciences, Virginia Tech, Blacksburg, VA, USA, (8) Departamento de Geofísica, Universidad de Chile, Santiago, Chile, (9) Geological Sciences, Northwestern University, Evanston, IL, USA, (10) Departamento de Ingeniería Informática, Facultad de Ingeniería, Universidad de Playa Ancha, (11) Civil & Environmental Engineering, University of Southern California, Los Angeles, CA, USA

On 27 February, 2010 a magnitude Mw 8.8 earthquake occurred off the coast of Chile's Maule region some 100 km N of Concepción, causing substantial damage and loss of life on Chile's mainland and the Juan Fernandez archipelago. The majority of the 521 fatalities are attributed to the earthquake, while the tsunami accounts for 124 victims. Fortunately, ancestral knowledge from past tsunamis such as the giant 1960 event, as well as tsunami education and evacuation exercises prompted most coastal residents to spontaneously evacuate to high ground after the earthquake. The majority of the tsunami victims were tourists staying overnight in low lying camp grounds along the coast. A multi-disciplinary international tsunami survey team (ITST) was deployed within days of the event to document flow depths, runup heights, inundation distances, sediment deposition, damage patterns at various scales, performance of the man-made infrastructure and impact on the natural environment. The 3 to 25 March ITST covered an 800 km stretch of coastline from Quintero to Mehuín in various subgroups the Pacific Islands of Santa María, Juan Fernández Archipelago, and Rapa Nui (Easter), while Mocha Island was surveyed 21 to 23 May, 2010. The collected survey data includes more than 400 tsunami runup and flow depth measurements. The tsunami impact peaked with a localized maximum runup of 29 m on a coastal bluff at Constitución and 23 m on marine terraces on Mocha Island. A significant variation in tsunami impact was observed along Chile's mainland both at local and regional scales. Inundation and damage also occurred several kilometres inland along rivers. Eyewitness tsunami videos are analysed and flooding velocities presented. Observations from the Chile tsunami are compared against the 1960 Chile and 2007 Peru tsunamis. The tsunamigenic seafloor displacements were partially characterized based on coastal uplift measurements along a 100 km stretch of coastline between Caleta Chome and Punta Morguilla. More than 2 m vertical uplift were measured on Santa Maria Island. Tsunami propagation in the Pacific Ocean is simulated using the benchmarked tsunami model MOST (Titov and Gonzalez, 1997; Titov and Synolakis, 1998). For initial conditions the inversion model of Lorito et al. (2011) is utilized. The model results highlight the directivity of the highest tsunami waves towards Juan Fernández and Easter Island during the transoceanic propagation. The team interviewed numerous eyewitnesses and educated residents about tsunami hazards since community-based education and awareness programs are essential to save lives in locales at risk from locally generated tsunamis. Tsunami observations and modeling are critically important for the preservation of world heritage cites.