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April Contents

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Foss Maritime's ***Wedell Foss***, now with 50% more usable horsepower and a revolutionary new drive design, assists a Horizon Lines ship at the port of Tacoma. Photo by Bill Sutton courtesy of Foss Maritime.

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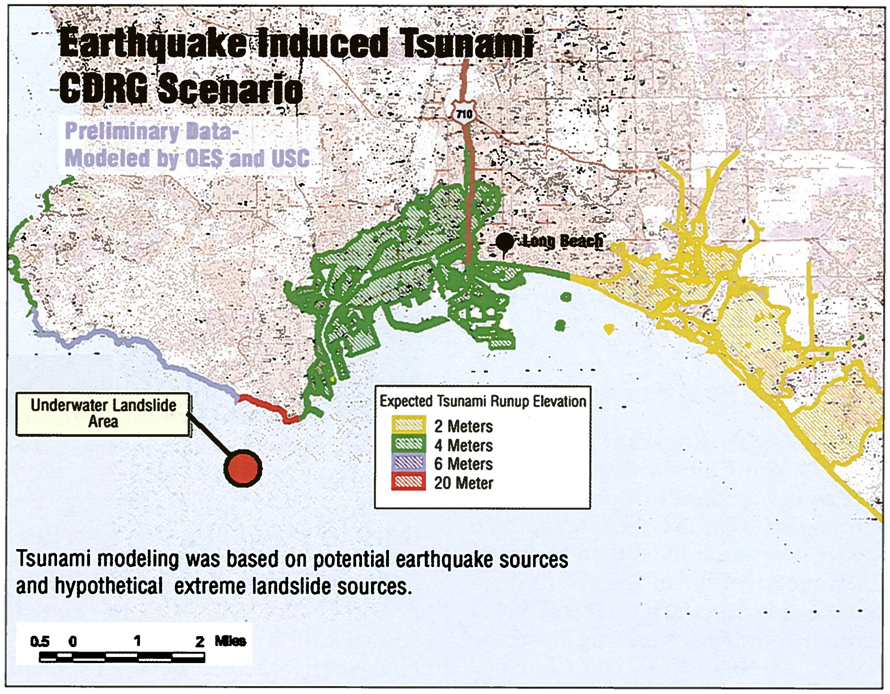
The Cost of Tsunamis in US Ports

By Jose Borrero, Martin Eskijian, James E. Moore, II and Costas Synolakis



The December 26, 2004 magnitude 9.0 Indian Ocean earthquake off the coast of Sumatra inflicted lethal tsunami waves across South and East Asia and Africa. The resulting devastation temporarily increased the attention California and US authorities give to tsunami threats and policy responses, such as warning systems and inundation maps. This increased attention could save lives in the US and around the world. Ports are affected in different ways than open coastlines. A tsunami's height may amplify inside ports, due to the repeated reflections of waves from the quays in a process known as ringing, similar to what happens when one taps on a drum. Even moderate tsunamis can generate significant water currents inside ports. An 8-foot tsunami in Manzanillio, Mexico in 1995 caused a 15 mph ocean current that was measured near the entrance of the local port.

Tsunami impact at the Ports of Los Angeles and Long Beach (POLA/POLB) is of particular importance to the local and national economy. Tectonic events associated with features of strike-slip faults offshore of Southern California create seafloor uplift and subsidence, which could trigger tsunamis. One of the largest such features lies directly underneath Catalina Island, a mere 22 miles from POLA/POLB. Simulations of tsunamis generated by uplift on this fault suggest waves in the ports in excess of 12 feet with arrival within 20 minutes.

Different Types

Tectonic tsunamis are just part of the tsunami risk present along the Southern California coast. New models of nontectonic tsunami generation were formulated as the result of unusually large waves associated with the 1998 Papua-New Guinea tsunami. This surprising wave was generated after a moderate onshore earthquake with an approximate magnitude of 7.0, yet generated inundation heights in excess of 33 feet, which claimed more than 2,500 lives.

The devastation along the Papua-New Guinea coast prompted scientists to rethink established paradigms, and search for alternative explanations for the causes of the catastrophe. Scientists now believe that the Papua-New Guinea tsunami was caused by a large submarine landslide triggered by the shore-side earthquake.

California's near offshore region, from Point Conception to the Mexican border, is characterized by a mainland shelf that runs from the shoreline to depths of 200 to 300 feet, varies in width from two to twelve miles, and is periodically cross cut by deep canyons. The shelf is broadest in Santa Monica Bay and immediately south of the Palos Verdes Peninsula, where POLA/POLB are located. Annual rains and infrequent floods load the shelf and canyons with new material, and the slopes offshore of Southern California generally have thick accumulations of water-saturated sediments. Under these conditions, seismic activity can trigger submarine landslides, and scientists have documented evidence of submarine landslides along many offshore canyons, slopes, and headlands in Monterey Bay and for the Santa Barbara Channel to San Diego County.

Difficult to Estimate

At present, there is no way to know whether most of these features were generated as single catastrophic events, or through slow gradual movements over time. Estimates of the tsunamis from these events range from 12 to 50 feet.

More accurate estimates are difficult for now, because science knows so little about waves generated by submarine landslides. What we do know is that a feature on the San Pedro escarpment, southwest of the Palos Verdes Peninsula, may have triggered a potential significant submarine landslide at some point in the past, if it all failed at once. If such an event happened today, the wave might reach a height of 30 feet along the steep cliffs of Palos Verdes peninsula, west of the entrances of POLA/POLB. The ports might be subjected to a wave with a height up to 15 feet. The ports might not be entirely protected by the existing or new breakwaters, because the wavelength of a tsunami is so long. The repeat period for such events is harder to quantify, but this is also true for the segment of the Sumatran trench that ruptured in December.

If recovery in the POLA/POLB infrastructure took one year, we estimate that the lost economic productivity associated with the inundation in this tsunami scenario would be $43 billion.

These effects would be felt throughout the entire Southern California region. The cost of replacing and repairing damaged facilities would be in addition to these costs. Nationally, productivity losses would be even greater, and by some estimates much greater. In contrast, the cost estimates for the 1994 Northridge earthquake range from $7 billion to $12 billion, including repair and replacement costs. The potential economic losses associated with damage to the ports outweigh the totals from the remainder of the inundated region by a factor of five.

Other Areas at Risk

Many other US ports and coastal facilities may be at risk. In 1994, a submarine landslide triggered a tsunami in Skagway Alaska, killing two people and destroying a dock used by cruise ships. Replacement costs were in excess of $30 million, excluding the litigation costs that ensued. Studies are under way by the National Oceanic and Atmospheric Administration (NOAA) on the tsunami impact in Seattle and its port. Inside San Francisco Bay, preliminary studies undertaken in the wave of the 1999 earthquake in Izmit, Turkey and the resulting tsunami, which led to refinery fire and a 6-inch thick oil slick in local marinas, suggest larger than expected currents inside the Bay. Along the East Coast, the possibility of offshore landslides has been identified on the New Jersey shelf, as have cracks suggesting unstable submarine conditions off the coast of Virginia and North Carolina.

The consequences in terms of inundation have yet to be examined, and more detailed seafloor maps are needed everywhere along the US coastlines to better identify offshore hazards. Further, while the risk resulting from submarine landslides may be hard to quantify given existing knowledge, the tsunami risk from tectonic sources remains undiminished.

In addition to the international steps taken to assist with tsunami warning centers and education in less developed nations, US maritime authorities could undertake a comprehensive tsunami hazard assessment of major US shipping ports, starting with the Ports of Los Angeles and Long Beach. This assessment could be an important first step toward meaningful policy responses. Hardening port infrastructure would be expensive, but the economic cost of a significant tsunami would be many times greater, and Los Angeles region is at particular risk. PMM

Jose Borrero is a Research Assistant Professor of Civil Engineering at the University of Southern California. Martin Eskijian is the Engineering Supervisor of the Marine Facilities Division, California State Lands Commission. James E. Moore, II is Chair of the Department of Industrial and Systems Engineering at USC, and a Professor of Civil Engineering, and of Public Policy. Costas Synolakis is a Professor of Civil Engineering at USC, and Director of the Tsunami Research Group.